MACHINERY.

VOL. 3. September, 1896. No. 1

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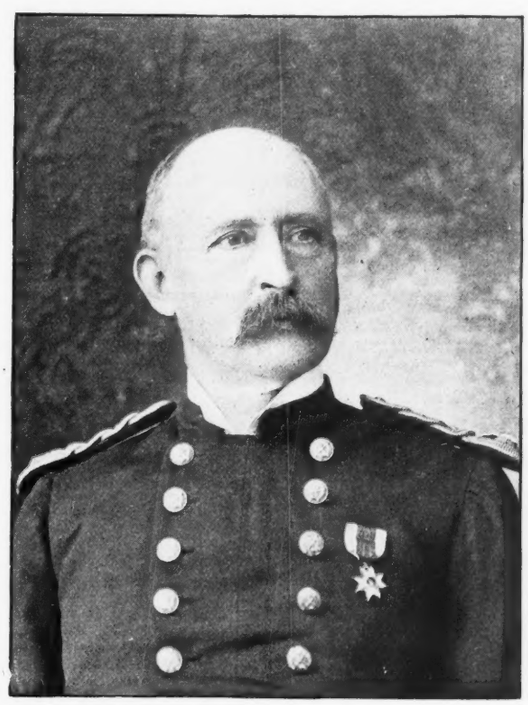
THE WATERTOWN ARSENAL.—1.

ALTHOUGH established when the present century was a callow youth of sixteen years, the United States Arsenal at Watertown, Mass., comprising about a hundred acres on the Charles River just outside of Boston, has been really engaged in making war material only since 1893. It is refreshing to see the progress that has been made since Major J. W. Reilly, whose portrait appears herewith, was sent to take charge of the place and place it on a sound footing to compare with the Watervliet Arsenal and to co-operate in the building of the heavy guns by furnishing the carriages and other mounts, without which the guns could not even be used for Fourth of July celebrations, to say nothing of striking terror to would-be violators of our coast. The guns are made at Watervliet, the carriages here, and they are assembled at the place assigned for test or service, as the case may be. This division of work is entirely modern, and follows closely what is being done in private shops, which shows that advances are being steadily made and that the idea of building one thing *well*, rather than half a dozen of only medium quality, is growing.



J. W. Reilly

The work in hand at present consists of carriages for eight, ten and twelve-inch guns; converting some of the old-fashioned mounts into more modern ones, and making projectiles of about all sizes, shapes and kinds that are supposed to be used in modern warfare. This includes the entire range, from the small but lively rapid fire to the massive shell, which the coast defense mortar is supposed to drop on and pierce the deck of the enemy's vessel, and which weighs half a ton.

When Major Reilly was sent to Watertown to make it into a modern plant, the prospects were anything but encouraging, and the inactivity of a quarter of a century had to be wakened into life according to modern ideas. So well has he succeeded that within the short time he has been in command, the place wears a different aspect; the plant has been rebuilt in many respects and now employs about 230 men with the prospect of doubling this number when all the necessary changes have been made.

A good idea of the whole plant can be obtained from the view on page 2. This shows the foundry first, beyond it the two machine shops, connected by a wing, as can be seen on close inspection, and beyond these the forge shop. It will be noticed that a rope transmission is employed in driving from one machine shop to the other, and also to the foundry. They had just finished putting on the "summer" ropes when the writer arrived, the "winter" ropes being laid away until fall. This illustrates the expansion and contraction of metals rather forcibly, as one would think there was enough sag to take up any difference in length due to this cause.

Back of these buildings is the erecting shop, completing a very compact arrangement for a plant of this kind, as the buildings are all connected by shop car-tracks and all fairly well equipped with cranes of various kinds.

THE FOUNDRY.

A general idea of the plant may be obtained from the photograph, and some of the details will prove of interest to the mechanic. The foundry proper is 50 x 200 feet, while the furnaces occupy a room 22 x 180 feet. These are three in number, there being two cupolas of ten and twenty tons respectively, and in addition, an air or reverberatory furnace with a capacity of fifteen tons, making a total melting capacity of forty-five tons. The view in the foundry shows how the smaller shells are cast and gives a general idea of its equipment.

THE MACHINE SHOPS.

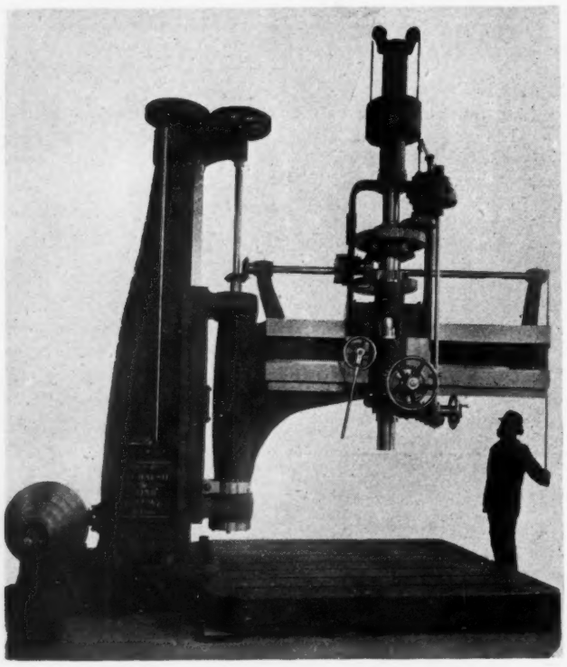
The new machine shop is really an extension of the foundry and is 50 x 100 feet, making the total length of building 300 feet, so as to be uniform with the others. This is shut out from the foundry by iron doors, which are kept locked to prevent fire being spread from the foundry by their being accidentally left open.

In this extension, or the new machine shop, as it is called, is to be found the large 96-inch radial drill, built by what is now the Baush & Harris Machine Tool Co , of Springfield, Mass., a photograph of which is shown on the following page.

This machine has a capacity and weight which is probably not exceeded by any similar machine in this country. The different bearings, which are subjected to great pressure and where ordinarily one would expect considerable friction, are fitted with either ball or roller attachments, by which great ease of motion is secured and the loss of power due to frictional resistance is reduced to a minimum. A good idea of the size and general construction of the machine may be gained from the view shown. The extreme height is 17 feet 6 inches; the bed-plate is 14 feet long, 8 feet wide and 10 inches deep. The greatest distance from end of spindle to bed-plate is 7 feet, and from face of column to center of spindle is 9 feet. The face of column is 2 feet wide and the saddle has a vertical bearing upon it of 5 feet 10 inches. The width of face on arm is also 2 feet, and the carriage has a bearing 2 feet 3 inches wide. The spindle is 6 inches diameter and is fitted for No. 6 Morse taper. The spindle has a traverse of 24 inches, with feeds of 160, 135, 95 and 55 revolutions per inch. The cone has five steps for 5-inch belt, the largest step being 24 inches diameter. The back gears are placed directly upon the spindle and are proportioned with a ratio of 10¼ to 1. There are ten

speeds of the spindle ranging from 5 to 285 revolutions per minute. The motion can be instantly reversed for withdrawing a tap, etc.

A special feature of the arm bearings is the patented ball and roller attachment, allowing of swinging the arm with the least possible effort. A careful test with spring balance showed that the arm and its attached parts, weighing over 13 000 pounds,



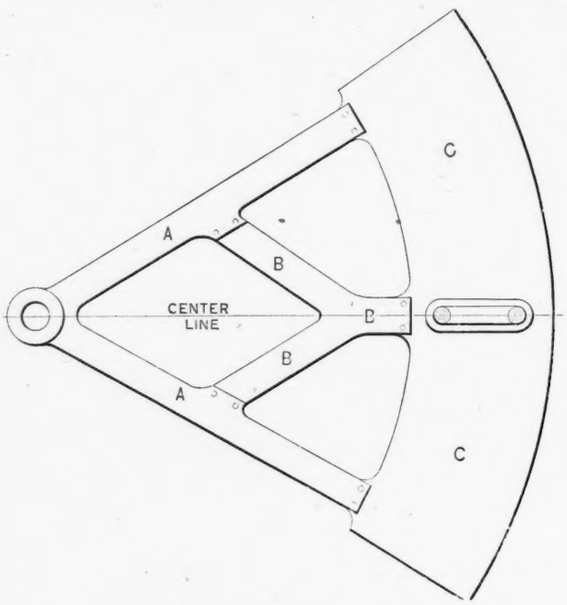
RADIAL DRILL, BAUSH & HARRIS MACHINE TOOL CO.

could be moved from a standstill into motion with a pull of seven and a half pounds, and that but about six pounds or a little over were required to continue the swing.

It was found in practice that the operator could readily move the arm by either pushing or pulling upon the hand-wheel, by which he moves the spindle vertically even with the carriage close up to the column.

At the end of the arm is a rod which slides vertically and is automatically sustained at any desired point. By this rod the arm can be swung at any height by a person standing upon the floor. The carriage rests upon anti-friction rollers, is moved by the ratchet and lever shown in cut and may be rigidly clamped at any point on arm by a single motion of hand-wheel. A small lever (shown just above name-plate) controls the gearing by which the arm is raised or lowered, and the elevating screw which carries the weight of the arm rests upon steel balls, and is so placed as to be perfectly protected from accident and injury. All important bearings are lined with bronze or babbitt, as desired, and gears are made from steel.

Going from here to the main machine shop, which is separated from it by an open space of perhaps fifty feet, some of the largest tools in the New England States are to be found. The large boring mills of the Niles Tool Works are shown on page 4, which are nominally 16-foot mills, but whose housings can be run back to take in twenty-five feet—large tools, but not large



RIG FOR PLANING AN ARC OF 15 FEET RADIUS

enough for turning the circular track for one of the large Buffington-Crozier disappearing carriages a short time ago. This will be mentioned later, however. These boring mills are extremely interesting to the mechanic, and a few details will be of interest.

The tables are driven by an accurately cut internal spur gear, which is driven by a steel pinion and bevel gears, insuring a steady drive without chatter or lifting tendency. For heavy work the spindle step is relieved slightly to bring the table to the annular bearing at its outer edge, making it both firm and accurate. The bars have a traverse of 48 inches and are of course counterbalanced. Their weight is about 400,000 pounds.

GENERAL VIEW OF THE SHOPS OF UNITED STATES ARSENAL, WATERTOWN, MASS.

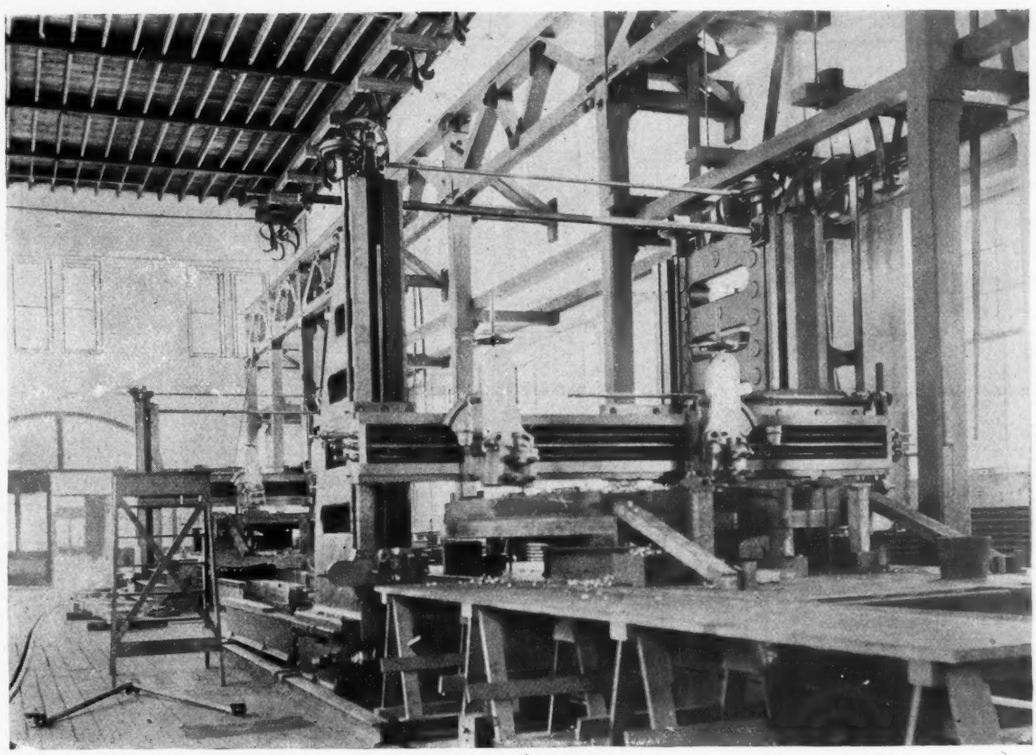
In addition to the regular extension boring mills the one shown below is novel in many ways. As will be seen, the column at the left carries a large boring bar 6 inches in diameter, in a heavy saddle sliding on its face. This bar is powerfully driven and has quite a range of feed in and out for boring, while the whole column moves on the base so as to assume any desired position with regard to the work. The work shown is a portion of one of

the disappearing gun carriages of the Buffington-Crozier type, which is now attracting wide attention.

The work is held on the circular table, which can be revolved to bring any portion into the range of the milling tool. This rests on a square cast base and the whole on massive founda-

In this view will be noticed a large Yale & Towne crane, with two trolleys, and the track at the left for the push cars which carry the work from one part of the shop to another.

The uses of open side planers are recognized here, and two of the well known Detrick & Harvey machines are to be found in



DETRICK & HARVEY OPEN SIDE PLANER.

GENERAL VIEW OF FOUNDRY—CASTING PRACTICE SHELLS.

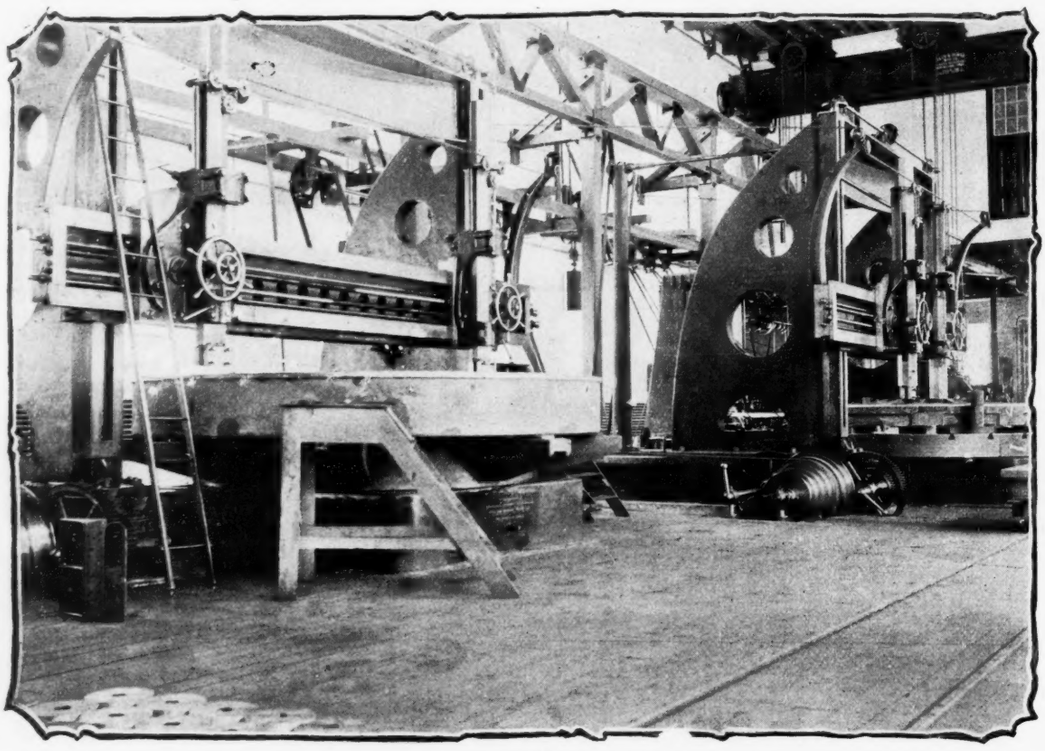
tions. And it may be said here that the introduction of heavy tools necessitated an immense amount of work in providing suitable foundations for them all, as it is well recognized that a solid foundation has much to do with the successful operation of a tool. The day of putting a heavy tool anywhere on the ground floor has passed by.

evidence, the largest size made by this company being installed.

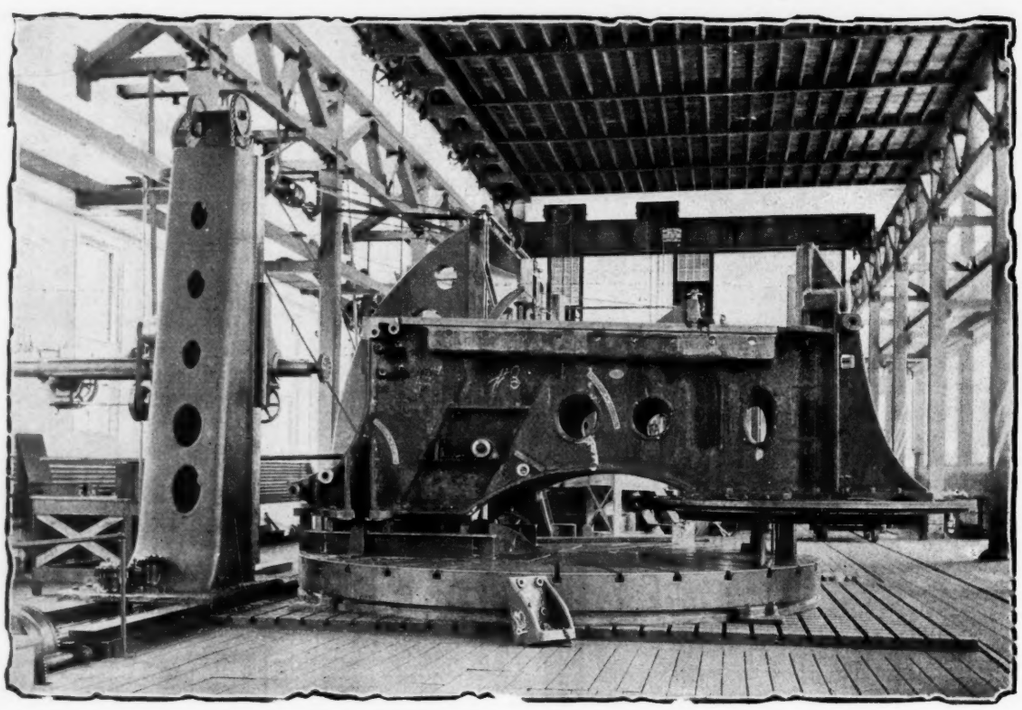
The last machine for this place was made heavier in some parts in order to suit their peculiar class of work. This planer is of the type designated as an extension planer, that is, it has an outer post, which can be moved laterally to suit the width of work, or which can be entirely removed to allow the machine to be used

as an open side planer. This post is for use only when two side heads are desired, or when the lateral stretch of the cut is greater than the machine, as an open side planer, is designed to plane. This machine is so designed that when it is used as an open side planer, the cross-beam can be slid in the beam housing, so that the outer end will not extend further than it should for an open side planer. This sliding does not interfere in any way with the feeds or any other function of the machine. The capacity of this machine is 8 feet high x 11 feet wide x 24 feet long. The driving gearing is necessarily much heavier than on any two-post planer of the same capacity, on account of its use as an open side planer. The feeds are by power in all directions, are independently reversible, and vary from $\frac{1}{128}$ inch to $1\frac{1}{4}$ inch. The cutting speed of the table is from 14 to 16 feet per minute, while the return speed is from 42 feet to 48 feet.

On one of these was rigged up a device for planing the big circular track before referred to, which was 30 feet in diameter and built up in six sections. This was accomplished in a very workmanlike manner by the men in charge, and will interest the mechanical reader. The small foundation seen to the left of the planer was put down for holding a center pedestal or fulcrum for the planing device, which was brought level with the bed and braced by the wrought braces shown on the floor. The jig itself is shown on page 2, and needs but few explanations. It was of



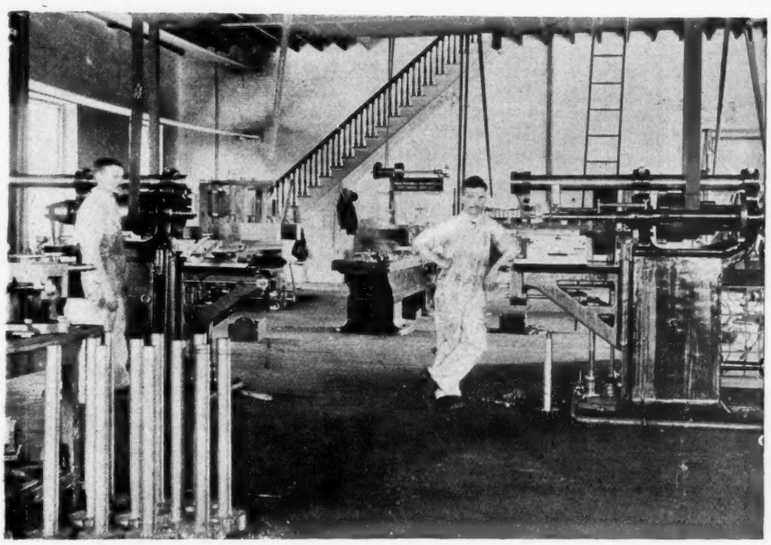
EXTENSION BORING MILLS, NILES TOOL WORKS.



COLUMN TYPE MILLING AND BORING MACHINE, NILES TOOL WORKS.

course pivoted on the raised fulcrum, and the connecting arms bolted fast to the jig, which held the section to be planed, the Y brace in the center adding stiffness and making it solid in that direction.

In the center of the chuck or table is a slot radial with the fulcrum, and in which played a roll on a hardened pin, fastened to the planer table. This roll was what drove the device, work and all, and as the mass of metal in the jig and section planed weighed several tons, the work was considerable. The man in charge very carefully laid out his lines on the jigs, and with the aid of set screws for clamping and wedging up, could set a piece very quickly and accurately, as well as mark off the correct planing lines for the end, so as to have them come exactly right, which was done in good shape in each case. While the idea is not new, it will probably be an addition to some one's store of knowledge, as we very often do not know of the little wrinkles being used in the shop next door.

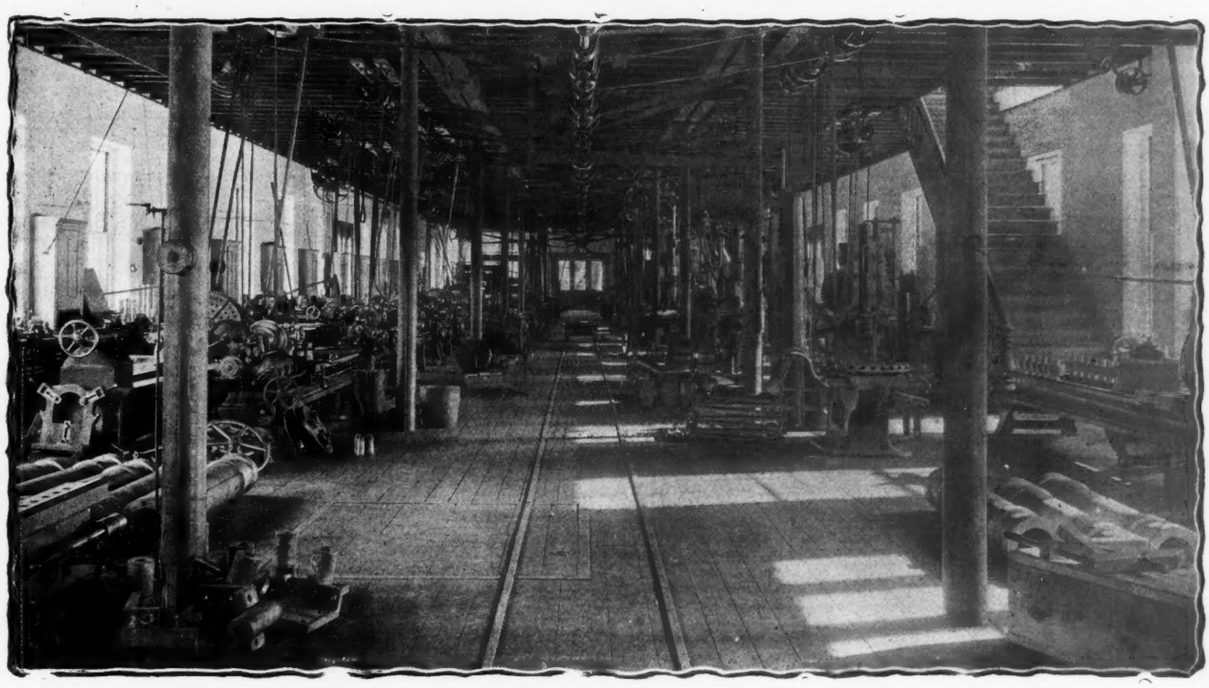


SECOND FLOOR OF MACHINE SHOP—PEDRICK & AYER CO. MILLING MACHINE—POWELL PLANER.

There are two machine shops side by side connected at the end by a 75-foot building, the right-hand bay is shown on page 5. This bay contains the smaller tools; the push or shop car track is shown in the center with one of the cars part way down the shop. The cone rollers shown on the lathe bed at the right belong in the base of some of the gun carriages.

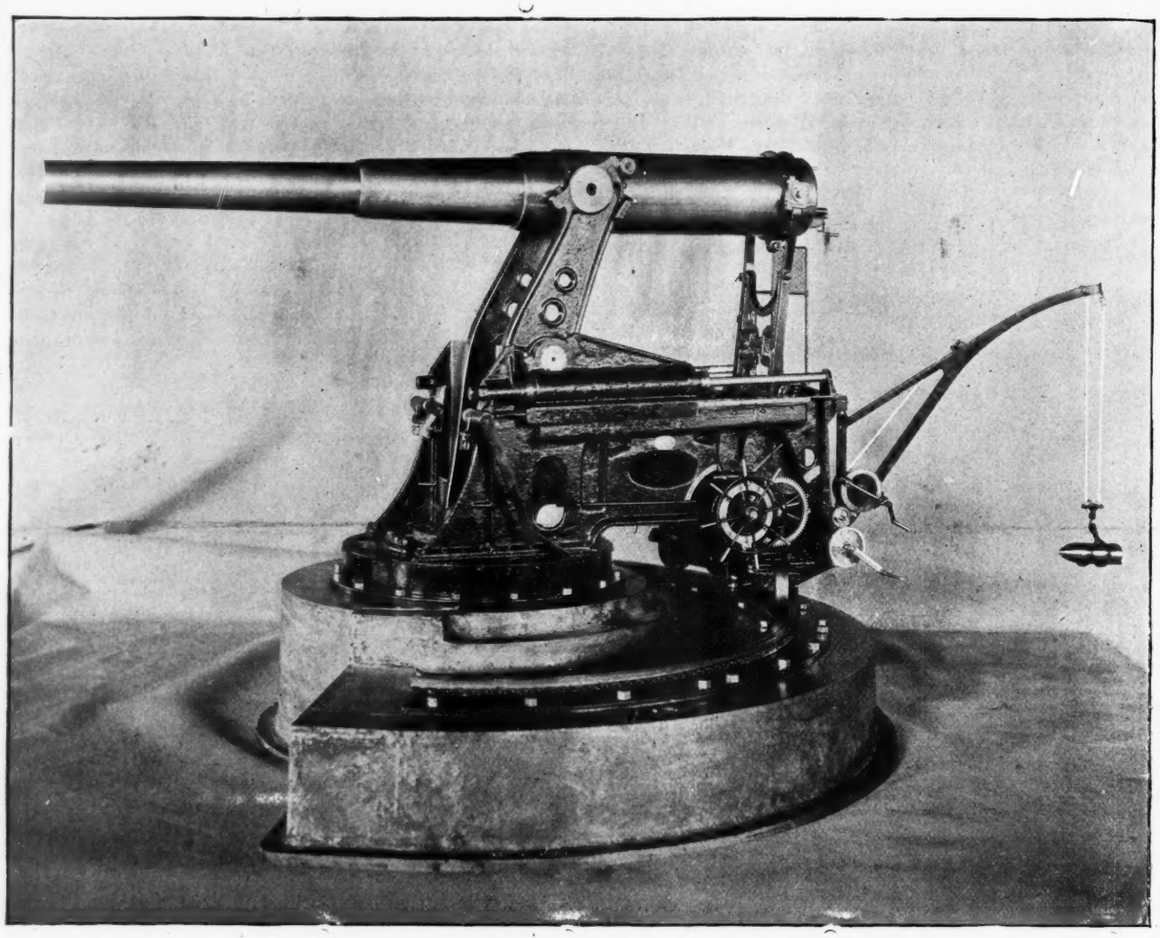
The tool equipment, both here and in the other departments, is of a modern character, the old tools being weeded out as fast as possible; some of them now adorn the yard near the buildings, presumably on their way to the scrap heap. The use of cutting-off saws seems to be appreciated here as elsewhere, and the Newton Machine Tool Works, of Philadelphia, Pa., are well represented in this line of tools. This type of milling machine (for that is really what it is) is one of the greatest conveniences as well as money savers that any fairly large shop can have. Going up stairs in this bay (the other bay with its large tools not admitting of a second story), we find more comparatively light machinery, such as milling machines, smaller planers, etc. The ones shown on page 5 are the largest size built by the Pedrick & Ayer Co., Philadelphia, Pa., and are heavy machines and do very heavy work. The planer in the background is of the Powell Planer Co., Worcester, Mass., make. On the same floor is a heavy vertical miller made by the Brown & Sharpe Mfg. Co., Providence, R. I., showing the practicability of this type of machine for surfacing work and the use of end or butt mills where possible.

Much remains to be said of the other tools and departments, which must be deferred until another issue, but before closing this article I will add a brief description of the Buffington-Crozier Disappearing Gun Carriage, two views which are shown on page 6. These are taken from a model, but are faithful representations of the larger carriage. This type of carriage embodies the popular idea in this line at present, and is the invention of two army officers.

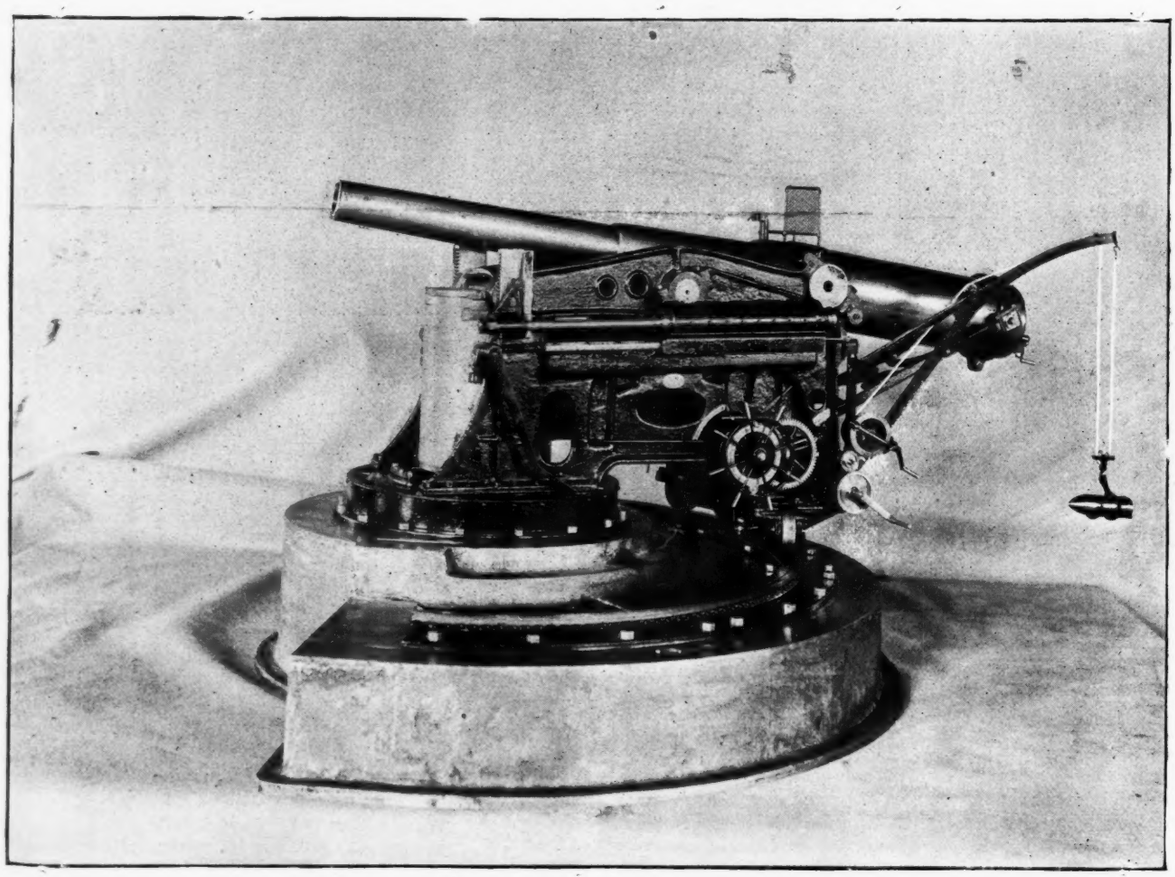


RIGHT HAND BAY OF MACHINE SHOP, WATERTOWN UNITED STATES ARSENAL.

The lower view shows the gun in position for loading, at which time it is protected behind the walls of the fort, and is not in view of the enemy—if there happen to be any around. The shell is hoisted up to the breech, the gun loaded, and the range being determined by the range-finders, the gun is trained to the desired position, indicators being provided to show the desired elevation, while an index on the circular track gives its lateral position. The counterweights, which are of lead and weigh about 37 000 pounds, are then released and the arms or levers in which the gun is mounted are thrown upward and forward. This can best be seen in the upper view. The oil cylin-



MODEL OF BUFFINGTON-CROZIER DISAPPEARING GUN CARRIAGE—IN FIRING POSITION.



MODEL OF BUFFINGTON-CROZIER DISAPPEARING GUN CARRIAGE—IN LOADING POSITION.

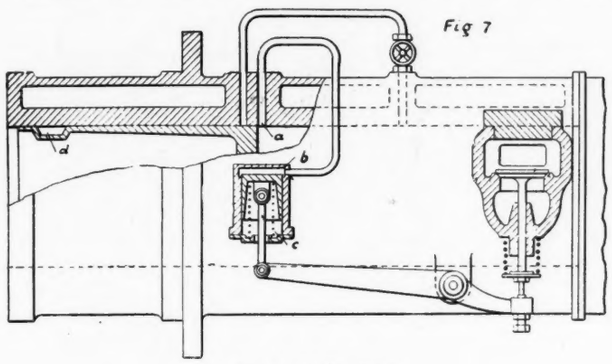
ders, which slide on fixed piston rods, as will be seen, move to the front end of the carriage, and the combined action of the levers throw the gun into the position for firing. As this takes only a small fraction of a minute the gun is exposed to the enemy but a very short time, and is comparatively safe. With six men working the gun, ten shots can be fired in fourteen minutes. When the firing takes place the recoil cylinders absorb about two-thirds of the "kick," the counter-weight being lifted into position by the remainder. The oil cylinders move back, carrying the center trunions of the side arms, and the gun is again ready to be loaded. The counter-weight can be seen in the center of the carriage, under the gun. Every provision for necessary adjustment is carefully looked after, and the carriage is a fine piece of work, mechanically and in general design.

* * *

THE GAS ENGINE.—3.

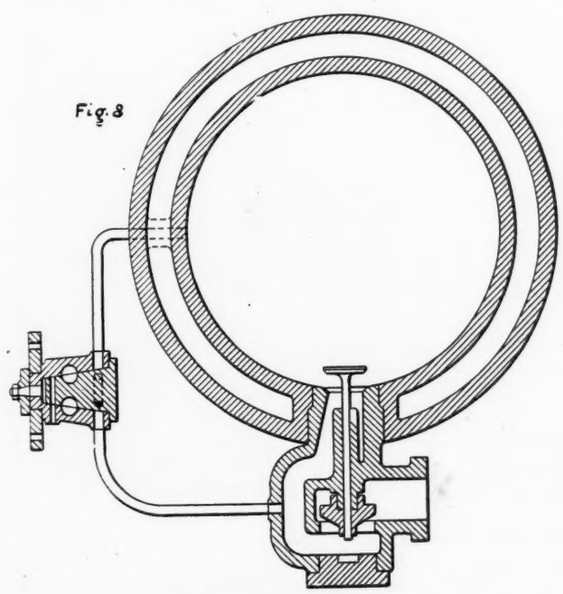
GEO. RICHMOND.

One of Otto's arrangement is shown in Fig. 7. At the end of the expansion stroke, the port *a* being uncovered, the gases rush into the cylinder *b* and force down the plunger *c*, thus lifting the exhaust valve against its spring by means of the lever shown.



ONE OF OTTO'S DESIGNS.

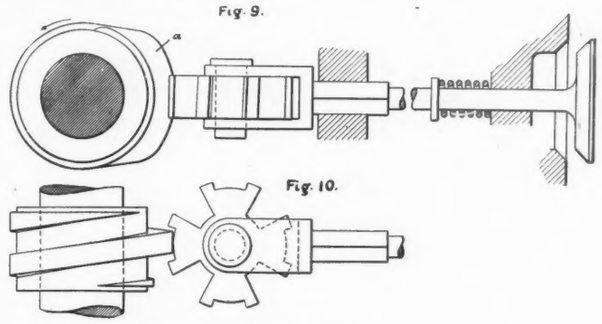
The port *a* being quickly closed by the return of the piston, the gas is shut off from returning and holds the exhaust valve open. At the end of the return stroke the port *d* in the piston puts the port *a* in communication with the waste pipe *e* and the valve is brought down by its spring. On the next forward stroke of the piston, the mixture in the cylinder being at atmospheric pressure, is insufficient to move the plunger *c*, and the exhaust valve



THE LANCHESTER METHOD.

remains closed. Fig. 8 shows the Lanchester method of doing the same thing. In this case the waste gases act directly on the exhaust valve stem through what may be termed an over-balanced equilibrium valve. The connection with the cylinder is controlled by a conical cock actuated by a ratchet-wheel, which is operated from the crank shaft. The ratchet-wheel is revolved one tooth for each revolution of the engine, and each second tooth puts a hole in the plug in line with the piping.

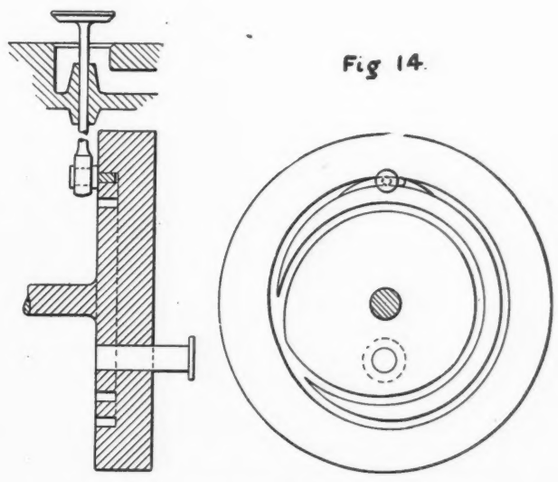
The same inventor has arranged for a two-cylinder engine which dispenses with all mechanism, the exhaust valves being actuated in a manner similar to that to be found in the steam moved valves of a duplex pump.



THE ROOT ARRANGEMENT.

A singular arrangement by Root is shown in Figs. 9 and 10. The crank shaft carries a worm, the thread of which is enlarged at *a* to form a cam. This worm gears with a worm-wheel fixed at the end of the valve stem. At every second revolution the cam gears into the raised tooth of the worm-wheel and pushes the valve open. On the next revolution it drops into the lower tooth and fails to move the valve. Figs. 13 and 14 show the method adopted in the Diamler motor of deriving the valve motion directly from the crank disc. For one revolution the shuttle follows the inner circle and the valve is not acted upon. On the next revolution the shuttle turns out into the outer groove and the valve is lifted off its seat.

This outer groove is not very correctly shown in the sketch, it being really a flat cam with the rise extending for somewhat less than a semi-circle. On the next revolution the shuttle re-enters the inner groove and so on. A somewhat similar arrangement is



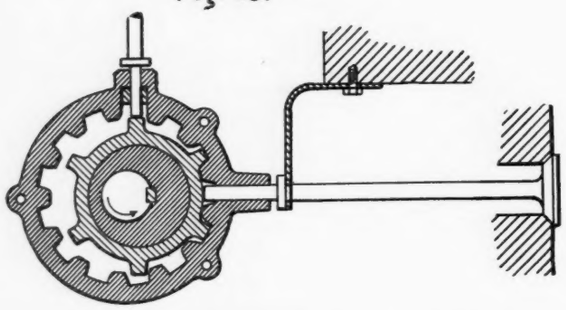
DIAMLER MOTOR METHOD.

used in the Globe engine. This is virtually the well known reversing motion obtained by running a shuttle along a shaft on which a right and left-hand square thread is cut. At the end of its travel along the right-hand thread the shuttle turns out and runs back on the left-hand thread. In this case one right and one left-hand thread is cut on a collar on the shaft which also carries the regular cam for lifting the valve. For one revolution the intermediate lever for lifting the valve is carried by the shuttle away from the valve stem. On the next revolution the left-hand thread brings it back and leaves it in the position to be acted on by the cam. To enable the lever to remain at rest during the operation of the cam the groove on the collar is not a true thread, but a cam. The valve is thus operated by a double cam, the one serving to bring the cam proper in operative connection with the valve.

Still another contrivance for obtaining suitable valve motion is that shown in Fig. 15, which will be recognized as similar to that

of the differential hoist. Every alternate revolution the inner wheel which is keyed to the crank shaft, presents a tooth to the valve stem and pushes it forward, thus opening the valve. On the next revolution a space is presented and the valve stem is not operated upon. Two rods at right angles can be operated by the

Fig. 15.



same inner wheel from which motion suitable for both suction and exhaust valves can be derived.

When gearing is used, all the work (which is considerable) of opening the exhaust valve is thrown upon a few teeth. An ingenious method of obviating this is shown in Figs. 16 and 17

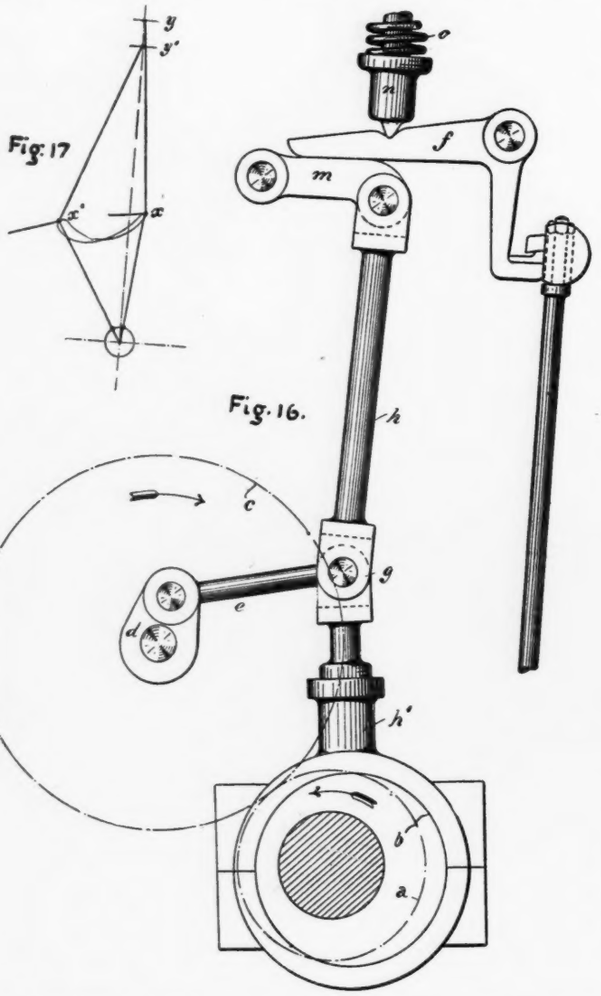


Fig. 17.

Fig. 16.

and used on the Grob engine. The two-to-one gear is used, not to operate the valve, but to determine the action of an eccentric which really actuates the valve. The connecting rod is jointed at g, and on one revolution the toggle e straightens it and enables the eccentric to operate the valve. On the next revolution it draws the joint of the connecting rod away to x^1 in Fig. 17 and the eccentric fails to lift the valve. Thus the real work of lifting the valve is done not by the gear wheels, but the eccentric.

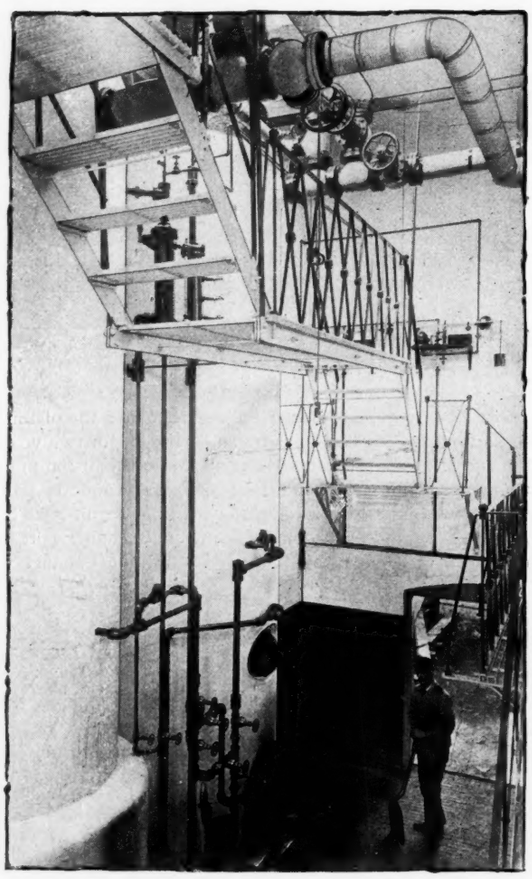
Other combinations might be shown for actuating the valves of a gas engine, and many modifications will at once suggest themselves. Those given, however, fairly cover the field, and the ingenious mechanic should have no difficulty in selecting and adopting a means suitable to his immediate purpose. He should be warned, however, that mere ingenuity in devising something new is of less value than correct judgment in selection. Above all, a new combination should be thoroughly tested on a model before building in any quantity, for it frequently happens that the most promising device turns out to be very objectionable, either on account of noise or unequal wear, or from the more serious drawback of being unelastic; that is, not easily susceptible of adjustment.

* * *

A NEW POWER LABORATORY.

SIDNEY A. REEVE.

The Worcester Polytechnic Institute has just completed, in all essentials, the equipment of two new laboratory buildings belonging to its department of mechanical engineering, which are worthy of description. One of these, a three-story-and-basement building of brick, is occupied more exclusively with matters mechanical, only the basement being accessory, in some of its apparatus, to the power laboratory itself.



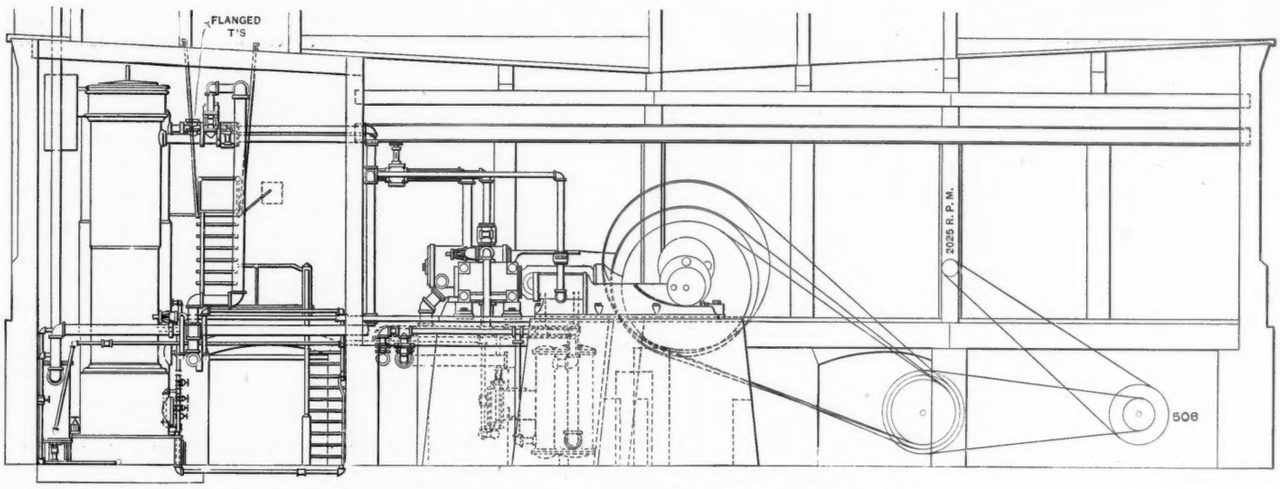
BOILER ROOM, POWER LABORATORY.

Between this mechanical laboratory and the Washburn shops, and with its basement on a level with those of its neighbors, stands the new laboratory devoted entirely to the study of questions in power development and transmission, by means of steam, gas, or electricity. Problems in water power are already provided for at the hydraulic experimental station belonging to the institute at Chaffinsville, five miles north of the city.

The building itself in external appearance, is the usual one-story affair of brick, but its roomy basement beneath the engine room makes it practically a two-story building. The plan dimensions are, for the engine-room, 53 feet 3 inches square, and for the boiler-room, which flanks it and runs from basement floor to roof without a break, 26 feet 4 inches by 18 feet 7 inches. The other corner of the building is given up to a power-gas generator room of equal size and shape to the boiler-room.

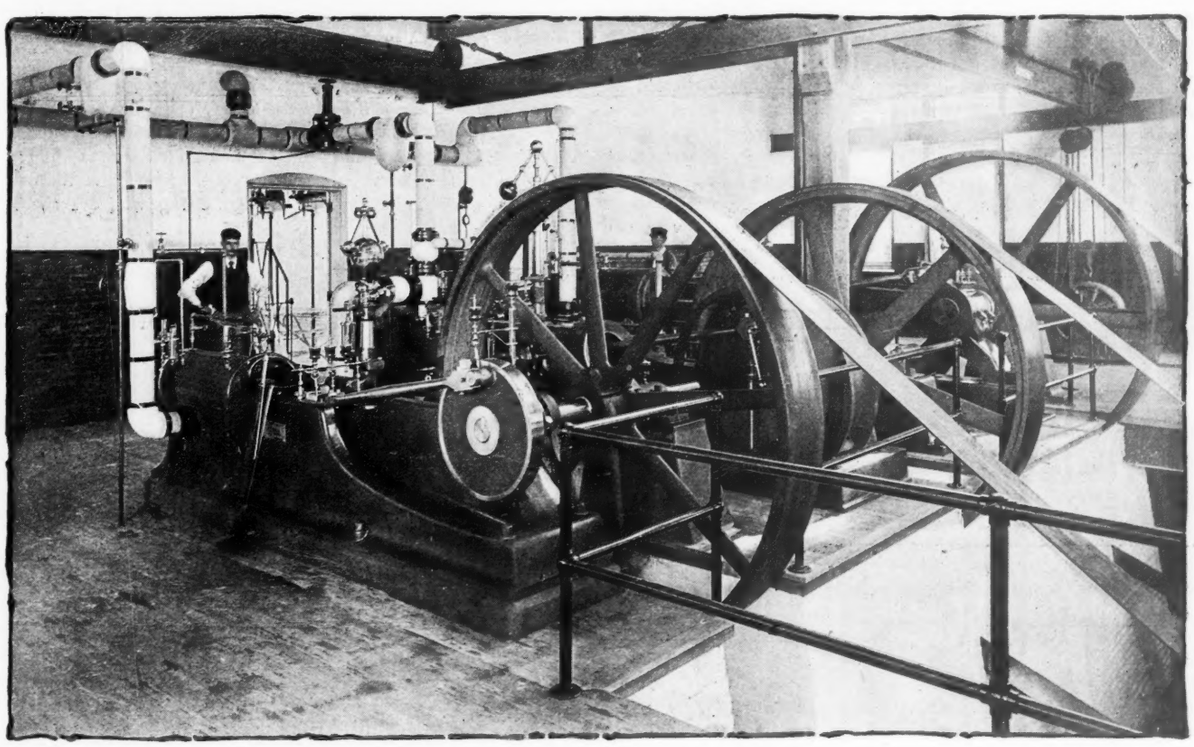
In the boiler-room are erected two vertical boilers of a nominal capacity of 80 HP. each, one of the Manning type and the other of a plain cylindrical design gotten out by Edwin Reynolds, of Mil-

waukee; both boilers, however, were built in Worcester, of a weight fit for 150 pounds working pressure. The piping is all extra heavy, and the feed-lines so arranged that either city pressure, donkey-pump, or steam-loop action can be brought to bear, either through or around the feed-water heater, for the supply of feed-water; the returns from the heating systems in laboratory and shop are also brought in. Every allowance is made for isolating either boiler for testing purposes, under any set of conditions, the pipe connections being all made with flanges into which can be inserted blanks to obviate hidden leakage. All radiating surfaces are carefully covered, and the tests so far made upon the boilers reveal a supply of continuously superheated steam. Each boiler is fitted with its own safety-valve and damper regulator.



CROSS SECTION OF BOILER AND ENGINE ROOM, NEW POWER LABORATORY.

The steam-lines from the boiler lead to a 5-inch main in the engine-room, from which are taken the supplies to the three engines; a 7 x 20 inch Putnam, a 10 x 30 inch Allis-Corliss, and a 16 x 30 inch Wheelock. These sizes offer a cylinder ratio, for triple compounding, of 1:3.06:7.83. The exhaust from each engine runs into the basement, where it can be sent in either of three directions: (1) out into the atmosphere through the feed-water heater, (2) into the surface-condenser, or (3) through a surface reheater into the steam-line of the next larger engine, this provision of course not applying to the Wheelock (the largest) engine. This surface condenser can discharge its condensed steam into a weighing tank or to waste at the throw of a light oscillating trough, and can operate either at atmospheric pressures or under vacuum. Its circulating water can be supplied either from city mains or from the pressure-tank in the basement of the mechanical laboratory, and can thus be used over and over again or be more or less diluted with fresh cold water. The discharged circulating water is carried back into the hydraulic apparatus in the mechanical laboratory basement, where it can be measured either by orifice, by weir, or by weight, the two big weighing tanks used in alternation offering ample capacity for measuring the entire flow from the condenser.



GENERAL VIEW OF ENGINE ROOM, WORCESTER POLYTECHNIC INSTITUTE.

The surface reheaters beneath the engine-room are fed with boiler steam, and the drips from them are led into small receivers fitted with gauge-glasses, from which the condensed steam can be drawn off and weighed. The drip-lines from all the engine

jackets, the barrel and head-jackets separately, are led to precisely similar receivers. The result of all this is that any or all of the engines can be operated and tested under any conceivable combination of conditions: condensing or non-condensing; singly, any pair in compound, or all three in triple-expansion; and with jackets on or off and cylinder or portions of cylinders desired. The delay in the delivery of a portion of the equipment has so far prevented any advantage being taken of these manifold and alluring possibilities, but by the first of September all will be complete to the last detail.

The arrangement of shafting and belts is equally advantageous for experimental combinations. Through the basement in front of the engines, and extending through the tunnels upon either hand into the basements of mechanical laboratory and Washburn Shops respectively, runs the main line shaft. Its horizontal offset is 14 feet 8 inches, and its vertical drop about 8 feet 6 inches from engine shafts, giving a mean length between centers of about 17 feet. The engines, all of whose speeds are adjustable, normally operate at about 100 revolutions per minute, and this line-shaft at about 200. On the line-shaft are four quills, each carrying two pulleys and a jaw-clutch for connection with the shaft. To one pulley on each of three quills runs a main engine-belt; the fourth quill is reserved for a large gas engine to be installed later, and also for a 70-horse electric motor, utilizing current brought down from the hydraulic station at Chaffinsville. From the second pulley on each quill runs a belt across to a clutch pulley on a lighter shaft calculated to run at 500 revolutions, the distance between belt centers being 14 feet. This shaft serves a double purpose: of carrying an Alden absorption dynamometer, and of driving back to the dynamos on the main floor, which furnish current to the physical and electrical laboratories and for lighting the buildings. These dynamos comprise a 500 light single-phase Westinghouse alternator, a 500-volt 60-kw. direct-current machine, and a 110-volt direct-current machine, all fully equipped with switch-board apparatus.

A few moments' consideration of this rig will show how easy it is to divert the power from any one, two, three or four of the engines, or from the motor to (1) the Washburn Shops, (2) the mechanical laboratory, (3) the dynamometer, for absorption or measurement, or (4) to the dynamos, for generation of current for useful purposes or for absorption and measurement, and (5) how, while any one lump of power is going to either dynamometer or dynamo, any other lump can be sent independently into the shops or laboratory, or both. As a piece of apparatus for the study of almost any problem in electro-mechanical power, it is hard to imagine how it could be surpassed. To complete the convenience of carrying out any proposed experiment, the engine is equipped with two overhead traveling cranes, which together cover the entire 2,850 square feet of floor space, and which are equal to lifting by hand-power any piece of metal now in the room or ever likely to be.

* * *

THE WIDE BELT HERESY.

W. L. Cheney.

There is no more friction between a wide belt and a pulley than between a narrow belt and the same pulley, other things being equal. A wide belt will pull more than a narrow belt when, and *only* when, it is *stretched tighter*. For instance, take an engine properly designed to run a belt 12 inches wide; if it were possible to make from some new material a belt 1 inch wide, that would be *as strong* as the 12-inch belt, the engine would furnish just as much power to the line shaft as if the 12-inch belt were used.

Of course the practical result of trying to run a 1-inch belt on an engine properly designed for a 12-inch belt, would be that the 1-inch belt would either break or stretch, and of course would not transmit the power. A *new* belt would most likely stretch and slip, and from this fact there has arisen a widely accepted idea that mere width of belt will transmit power.

A properly designed machine would have a driving pulley a certain diameter, and the diameter would be in proportion to the size of the journal of the shaft on which the pulley is fixed. The belt used should be *narrow* enough so that it *cannot* be stretched tight enough to bring more pressure on the journal than it is designed to stand, and of course the face of the pulley should be right to take such a belt only. Good design, then, would forbid the use of a belt any wider than a certain fraction of the diameter of the pulley; of course there are some practical exceptions, such as a dynamo or a circular saw where high speed is necessary, and which cannot be had except by making the driving pulleys small diameter and wide enough to take a belt that will not stretch. This is bad design, but seems to be necessary in such cases.

It is belt *speed* and not belt *width* that transmits power. Any "old timer" will testify that the old original "Colt" and "Lincoln" milling machines will do very much more work than many modern milling machines, various reasons being given, such as: "The Lincoln miller has a worm gear in the feed which gives lots of power," and "The Colt has a *large diameter* screw to feed the table," and others with about as much sense (or want of sense), but the true reason is very easy to see. The spindles of these machines are adjustable vertically, in consequence of which the feed belt pulley was of necessity placed on the driving shaft, instead of on the spindle; the designers of these machines were thus driven into the use of a quick running feed belt which would transmit power and plenty to spare, to the feed mechanism, in spite of themselves.

I say "in spite of themselves," because I think they "builded better than they knew," and the reason why I think they blundered into a good thing, is because just as soon as the knee type of milling machine came into existence, and in consequence it became possible to put the feed belt pulley on the slow running spindle, they did so, and made a machine that "wouldn't mill the scale off a doughnut." Every maker of Lincoln milling machines that I know of did this, and kept on doing it until C. E. Lipe made a milling machine on a principle that involved quick running where power was to be transmitted, both to spindle and feed mechanism. If a Lipe machine is examined, the driving belt will not seem wide, but it runs fast, and the feed is run by a narrow friction wheel, which also runs fast; in consequence of which the machine was described by a writer in a contemporary, who was investigating milling machines, as doing more work than any other milling machine of equal size; and it did not take Brown & Sharpe long to see that Mr. Lipe had struck the proper thing, in consequence of which the Lipe machine is now made by the Brown & Sharpe Mfg. Co., who bought the whole thing from Mr. Lipe.

I have been looking at two planers standing side by side in the same shop; one is about twice the size of the other. The small one has a 1-inch belt, the large one a 1¼-inch belt; the small one will take a chip that would bring the large one up standing; the belt of the small planer goes 50 per cent. faster than the belt of the large one. Modesty forbids mentioning who designed the small one.

To review and sum up: The only reason why a wide belt will pull more than a narrow one is, that it can be strained tighter than the narrow one; this brings undue pressure on the bearings of the shafts or spindles, and is in every way bad. No pulley should be wide enough to take a belt so wide that there is any possibility of straining it tight enough to bring any more pressure on the bearings than they can *easily* stand, and any designing that admits of a belt that will bring too much pressure, is *bad* designing. If there is any possibility of a wide belt laced too tight and put on by main strength, there will not be found wanting, plenty of men who will furnish the strength, and glory in it.

When we once realize that the driving power of a belt is in its *strength* rather than in its *width*, it is easy to see why a round belt will often pull more than a flat one: for instance, a common size of belt on feed pulleys, is one inch wide, and if ⅛-inch thick, which is about the average of 1-inch wide belt, the "area of cross section" is evidently ⅛ of 1 square inch, or in decimals .125, whereas the area of a round belt ½-inch diameter is .196, or a little more than 1½ times as much as the 1-inch wide belt, and will, therefore, pull a little more than 1½ times as much without stretching, and will, in consequence, carry a little more than 1½ times as much feed.

This thing is beginning to be more understood, and all the *later* millers by Brown & Sharpe, Kempsmith, and some others that I do not now think of, embody this quick running principle.

* * *

With the prices of machinists' tools at their present low figures it hardly pays any workman to attempt making calipers or similar tools. If the stock and time are both free, he may save a little money, but as a rule, he will never be entirely satisfied with the "home made" tool.

THE ORIGINAL CORLISS PUMPING ENGINE.

LESTER G. FRENCH.

The first pumping engine built by George H. Corliss has been recently removed from the Hope pumping station, Providence, R. I., where it was installed in 1873. It was designed to pump directly into the water mains of the city, and to maintain a constant pressure at all times, whatever the demands upon the system might be. It was also expected to run smoothly and steadily at all speeds within its range. These conditions it fulfilled in a satisfactory manner; but, unfortunately, in point of economy it was a signal failure. Whether Mr. Corliss himself expected a higher duty than was actually obtained, and if so, how much higher, can be stated only by those who were personally acquainted with the facts at the time.

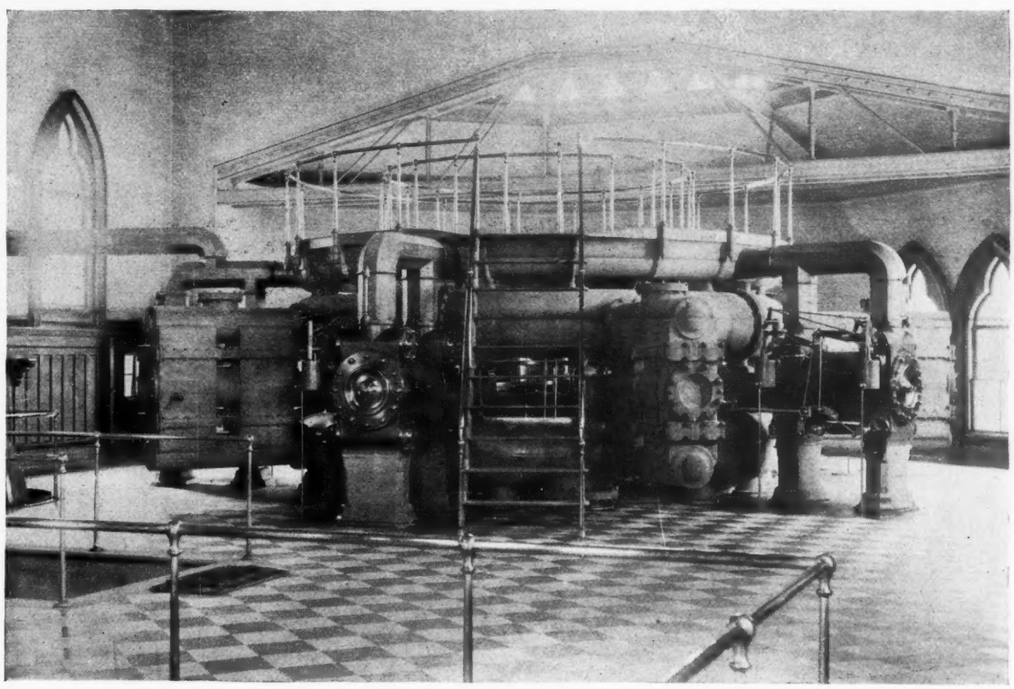


FIG. 1.—GENERAL VIEW—THE ORIGINAL CORLISS PUMPING ENGINE.

Fig. 1 gives a general view of the engine as it stood in the station. There are five steam cylinders arranged alternately with five pump cylinders about the circumference of a circle, all of them set radially. At the center of the circle is a vertical crank-shaft, having a single crank at its upper end. The five pumps are driven through the medium of this one crank and the ten connecting-rods, piston-rods and cross-heads necessary to connect it to the steam and water pistons. Fig. 2 is a view looking down upon the crank shaft and shows the arrangement of the rods. The rod at the right is expanded at the end in the form of an eye, large enough to include the crank-pin box, and pins for the other rods are placed at equal distances around the body of the eye. It is evident that there can be no dead center to the engine, and that if the cut-off occurs at about one-fifth stroke in each cylinder, the crank will be urged forward continually by a nearly uniform steam pressure, and at the same time steam will be used expansively. And moreover, the problem met with in any pump, of a constant water pressure to be overcome throughout the whole length of the stroke, is here solved without the use of a fly-wheel or other means of storing energy.

The inlet and outlet pipes for both steam and water are cast in the form of rings and are located just within the circle formed by the cylinders. They are plainly visible in Fig. 1. These pipes are connected with the steam or water cylinders at the necessary points, and each ring has one supply or discharge pipe leading to or from the engine. The exhaust pipe or ring serves as a condenser, water being injected into it, where it comes in contact with the exhaust steam. The air pump is driven by an inverted single-acting steam cylinder, with Corliss gear, controlled by a pendulum governor. The boiler feed-pump is driven by the same engine.

The valve gear is operated by a single eccentric, the connections being similar in arrangement to those of the crank and connecting-rods. The action of the gear is clearly shown in Fig. 3. The dash-pot plungers are connected directly to the valve-stem levers by a short link, and the same pin that attaches the link to the plungers also carries the knock-off hook, which is seen in the illustration in an upright position. The dash-pots are an old style, single plunger type, but it is interesting to note that among the original drawings of the engine, which were made in the latter half of 1872 and the early part of 1873, is a sketch embodying all the essential features of a modern dash-pot.

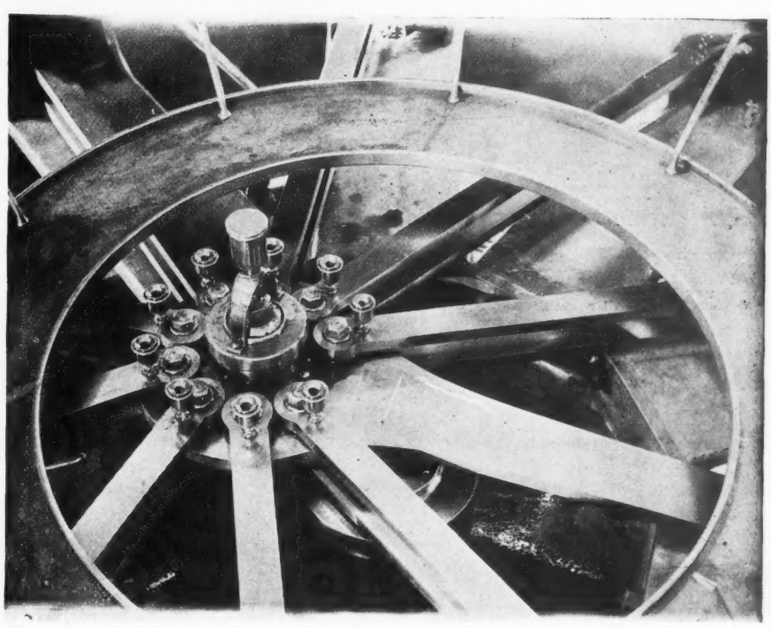


FIG. 2.—THE CRANK AND CONNECTING RODS.

As shown in the view of the valve gear, the points of cut-off on each cylinder are fixed. From the drawings, however, it is evident that Mr. Corliss schemed on an automatic cut-off. Whether this was to depend for its action upon the water pressure, a governor driven by the engine, or upon both, is uncertain; but it is

said that an automatic device of some sort was tried and proved a failure. However this may be, it is difficult to see how such an arrangement could have been other than a failure, owing to the liability of the engine stopping whenever the cut-off occurred too early in any one of the cylinders. During the greater part of the engine's service, it was regulated by a throttle-valve under the control of a pressure-regulator valve connected with the water main. In this valve the pressure on one side of a piston was balanced by a weighted lever. An increase in the valve pressure raised the lever and throttled the steam, and vice versa.

A governing apparatus was also provided, which regulated the speed of the air-pump between limits that the governor could not take care of, and also varied the supply of injection water as required. It was actuated by the flaps of a butterfly valve placed in the suction pipe. These would rise or fall as the quantity of water pumped, and hence the speed of the engine was greater or less.

A point worthy of note is that the outside of the valve chambers on the steam cylinders are made cylindrical in form, which, of course, is the most natural and graceful thing to do, although nearly all Corliss engine builders use the square, sharp corner for their cylinder ends. Another feature of these cylinders is that each one was cast in three pieces, the barrel forming one part, and the two ends, with the steam and exhaust valve chambers belonging to them, the other two. Gridiron valves, that lifted bodily from their seats by the action of the water, were used in the pumps.

The engine was 30 inch stroke, with steam cylinders 20 inches in diameter and water cylinders 12 inches in diameter, and was capable of running from 25 revolutions per minute to less than one revolution per minute. The best duty recorded at the official trial was less than 26 000 000 foot-pounds per hundred pounds of coal, though at the time of its removal it was doing better than this. The boiler pressure was 43 pounds. The design appears

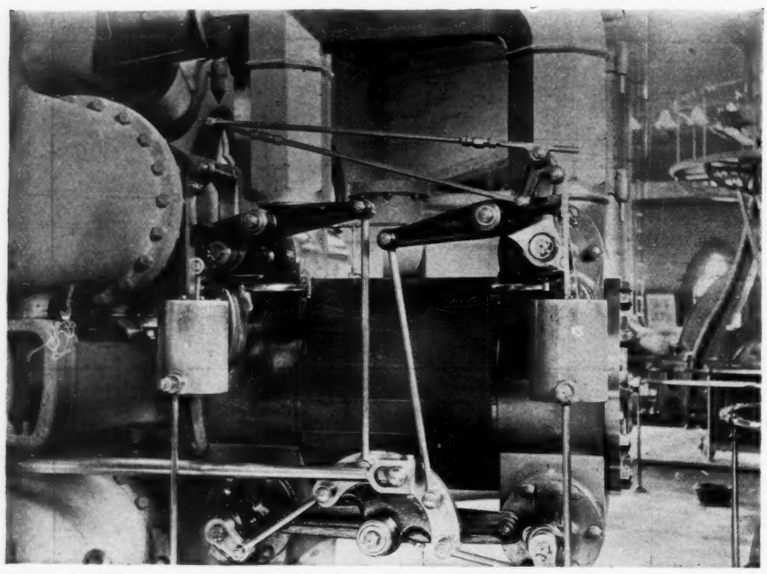


FIG. 3.—VALVE GEAR ON ONE OF THE CYLINDERS.

to be inconsistent, in that some things were employed, supposed to be conducive to economy—the trip gear, the early cut-off and the condenser—while the low steam pressure, the slow speed and the multiplicity of the steam cylinders, which made a tolerably good condenser of the engine itself, are directly opposed to all principles of economy. It is also a novelty, to say the least, to find a Corliss gear running with a throttling governor. Mr. Corliss thoroughly believed in certain of the engine's features, however, for the second pumping engine that he built was an experimental engine for his own works, which had five pumps arranged similarly to those at the Hope station, but which were driven by a single engine geared to run at a higher speed than the pump and provided with a fly-wheel. This improved form was designed to give a higher efficiency. No other engine like either of these was ever built.

ORIGIN OF THE ARABIAN NUMBERS.

JUAN de D TEJADA.

Since the most remote times known to history, our forefathers were undoubtedly in need of preserving their mental computations, by graphic methods, in such a manner that either the computer himself, or any one acquainted with the system, could readily ascertain the value of each and every portion of the computation.

There arose as a natural sequence the employment of special signs, created to denote numbers, which are not only older than writing, but older than the development of language and even speech.

Of alphabetic or graphic systems of computation there were many in ancient times, and among those more commonly employed, were, the Syriac, the Palmyrene, the Phœnician, the Eivatic, the Hieroglyphic, the Egyptian, the Ionic, the Semitic, and finally the Roman, which we use yet in our day, being natural as a great portion of our civilization and our laws and language come direct from the Romans. Rome shares with Greece the title of mother of the civilized world.

As to the Greek system of notation or sexagesimal system for such a long time directly connected with astronomy we use it to a great extent; most of our geometrical calculations are based and carried out in such system, and our time is measured by it.

These absurdities bequeathed to us by the ancients will disappear in due time, as will disappear, the irrational system of measurement with the English foot as unity. In time the decimal metric system will take the pla e of the aliquot divisions and come to the front, as the only one scientific and practical.

The system of computation by decimals originated no doubt in the use of the fingers of both hands, and the ancients, most assuredly computed by using such living numerals. Even now in our days there are many persons who use such means of calculation. The peasants of the Balkans in fact all the rural inhabitants above the Danube river, between Selimno and Pravadi, use nothing but such system of computation, and there are many of them so dexterous they can easily perform the operations of addition, subtraction, multiplication and division of all numbers below 1000 by such simple means. In ancient times such system was carried out as matter of course by the highest classes as well as by the plebeians.

The early Greeks of the times of Apollonius de Perga and specially the latter used to resolve problems of multiplication employing the decimal system but without the use of the fingers. The multiple of any number was called the *pythmen*.

The *abacus* of the Asiatic people, introduced in Greece at the time of the Persian wars, and the same one, of which we can see specimens in our large cities in the Chinese laundry shops by the name of *swan-pan*, is a sort of calculating machine lacking however the cypher (zero), hence the necessity of using counters or division lines along the strings to avoid confusion.

What is beyond any doubt, is that the decimal system of computation—not of notation—as practiced by us, is of Indian origin-

It is possible that from India it was carried to Arabia by an Indian ambassador, who carried the astronomical tables to Bagdad about the year 773 A. D. As a matter of historical fact the system was defined and explained early in the 9th century by the famous Abu Jafa Mohammed, and from that time was rapidly extended all over the Arabian world. In the 10th century it was quite well known in Spain. However in other parts of Europe it was entirely unknown until the 12th century, together with the system of arithmetic known as *alogaritmus*, name given to the system by Abu Jafa Mohammed. He invented also the word *sifr*, from whence came the corruption *zero* and to which Leonardo de Pisa, of whom we will speak presently, gave the name of *Zephyro*.

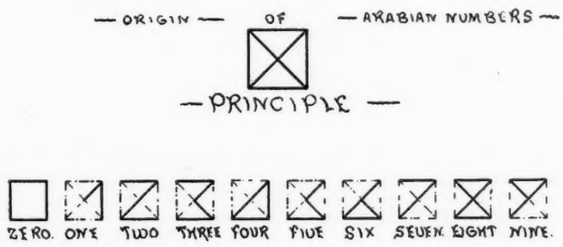
Before the introduction of the system alogaritmus in Europe, computations were imperfectly carried out by means of a sort of Asiatic *abacus*, slightly improved by the Greeks.

Bachet de Mezeriac one of the early members of the French academy, and the justly celebrated mathematician Fermat proved beyond discussion in their "Traduction" and "Comentaires." respectively of the treatise of algebra of the Greek mathematician, that Diophantus (the true founder of algebra) the portions of the original treatise of the latter found in the Vatican (Rome) was carried thither after the occupation of Constantinople by the Turks.

It will thus be seen that long before the revival of the works of Diophantus by Hypathia, and her followers in Europe, the Arabs were masters of the notable invention of algebra (Arabian) and also of the arithmetical notation we use in our days. They therefore introduced both into Europe in that dark age, when, after the invasion of the Barbarians from Northern Europe the latter was enveloped in the most brutal obscurity.

Had it not been for the perserverance and skill of that ingenious people, who kept alive the lamp of knowledge, our ignorance of exact computation might have been retarded many centuries.

The first elements of Euclid known in Europe were introduced in the Arabian tongue. A great portion of the works of Apollonius



de Perga are known to us by way of the Arabs, as the Greek original was lost.

However, the first book on arithmetic and algebra published in Christian Europe and using for the first time the Arabian system of notation, was that of Leonardo de Pisa, a merchant of the last named Italian republic. Leonardo had traveled a great deal during his youth through India and Barbary. The book of Leonardo although including arithmetic and algebra as a single or uniform system was the first step in the right direction. He used the nine digits and the Zephyro (zero) in all his demonstrations. That was in 1202, that is, two centuries before the discovery of printing by Guttenberg of Magdebourg.

The primitive Arabian numbers were named *Davogori* and in the writings of Ayro Batta the computations were illustrated with that system. The notation of the eastern and the western Arabs offered great differences. Those of the west—the ones transmitted to us were named *Ghobar*.

Three centuries after the publication of Leonardo's work and just thirty years after the discovery of America, the first treatise on arithmetic was published in England "De Arte Supputandi" by the bishop Tonstall—1522.

As is well known, when a quantity is expressed by means of words, the process is named *numeration*, but if the quantity be expressed in figures or signs then the process is called *notation*. Notation to the fullest extent is carried out using only the nine digits and the cypher or *zero*. It is clear of course that there are minor signs like the dots and commas, to denote and give decimal value to any quantity, by the position in which they are situated, increasing or diminishing the quantities by changing them either to the right or to the left.

The Arabians who have been in the past, as in the present times, the great masters of the mosaic art, in which field they have displayed such marvellous power of originality and conception, and whose magnificent combinations can be seen in the splendid iconostases of their Mosques, in their halls, and in fact, in all of their decorative art, conceived with a charasteristic idiosincracy a graphical system strictly geometrical to represent the figures of the decimal system learned from the Indians.

We have reasons to believe that the graphics of the so called Arabian numbers form a part of their system of *Arabesques* and that for both ends they took as a base or principle, the square and its diagonals. As will be seen by referring to the engraving, the nine digits and the zero are formed by the combination of the square and its diagonals.

I am satisfied that I can demonstrate in a future article, how a system of Stenography or Shorthand writing for figures—something we do not have as yet—can be learned in a few hours practice by using the above principles.

* * *

DEVELOPMENT OF SOME CONNECTICUT INDUSTRIES.

S. W Goodyear.

Familiarity with some industries peculiar to the Naugatuck Valley, and particularly with those of Waterbury, prompts the writer to attempt to interest your readers by brief mention of wonderful advancement in appliances and methods which has been made in the "Brass City" during the past forty-five years.

In the early fifties I worked as a machinist for the Farrel Foundry & Machine Co., then a small but progressive concern. which has grown to employ at present as many hundreds of hands as there were scores of us at the time mentioned, while the character of work has changed from that of furnishing such machinery and appliances as were in vogue then, until now in the different departments there are built such variety of machines, both heavy and light, as to seem marvellous to one who, like the writer, remembers the early beginning. Step by step from the building of ordinary mill machinery, has been developed the furnishing of power and hydraulic presses, rivet machines, drop presses, etc., with a line of automatic machinery, the excellence of which has obtained a world-wide reputation, and now nearly all that enters into making a complete outfit for a manufacturing plant in the metal line, can be furnished by the Waterbury Farrel Foundry & Machine Co., from the heaviest rolling mill machinery down to the lightest automatic machinery for which Waterbury is justly celebrated. There are other smaller concerns here, who build much light machinery of intricate character and of excellent quality, of whom Blake & Johnson and the E. J. Manville machine Co. are perhaps best known from having been long established, while the Waterbury Machine Co, through their building of automatic machines and wire drawing machinery, are coming to be well known, and are undoubtedly destined to fill a very important place in Waterbury's machine building.

Among all the interesting operations for which machines and appliances are furnished by Waterbury machine builders, there are none which have interested me more than that of "cupping" and "drawing" in sheet metal and the drawing of wire, and were investigation to be made in wire drawing establishments over a wide range of territory, or where the cupping and drawing of sheet metal constitute a part of the business, there is to be found machinery from these shops. "What is 'drawing'?" may be asked by readers who have had no opportunities for investigation in that line. It is, briefly, the reduction in cross-section, and consequent extension longitudinally, of metal by being either pushed or pulled through a die smaller than itself, thus depending upon both the malleability and ductility of the metal for the result; and the more judiciously the division line is made between these two principles the better the result. "Applied to what?" is asked again, and the answer, did it cover but a small fraction of the uses to which this principle of drawing is applied, would fill a large volume, instead of the little space into which I must try to crowd it.

Thimbles, ferrules, cartridge shells, lamp fixtures and thousands of hollow pieces of greater or less diameter and length, from down to small fractions of an inch up to house boilers, are drawn up from discs of sheet metal; the writer having knowledge of such cupping and drawing as began with a disc of over five feet in diameter, and ended with finishing this disc into a tube of over ten feet in length and nearly one foot in diameter!

Think of the force necessary to push such a disc of nearly one inch in thickness through a die, thus forming it into a cup; and then of the force and strength of machinery required to draw this cup to a tube as stated! This is but one way of starting in the manufacture of tubing. Bicycle tubing may be, as in some cases, made in this way; but it is probable that the bulk of tubing for the great variety of uses to which it is put, is either drawn from sheet metal cut into strips, formed into cylindrical shape and brazed, or from hollow ingots, or billets, produced by casting, boring, or by the wonderful Mannesmann process whereby a solid billet of metal, except that a shallow conical recess is first made in one end, is passed between rolls and over a conical mandrel, whereby it is transformed into a hollow billet or tube, having an inside diameter nearly as great as its outside diameter was originally, and with its length increased by four or five hundred per cent. To perform these initial processes and afterwards continue the drawing down to the finished products, has involved the designing and perfecting of a line of appliances in presses and draw benches and hydraulic machinery, of which the Waterbury Farrel Foundry and Machine Co. may well be proud.

It is likely that the general public is more familiar with wire, in its various sizes, shapes and uses than with any of the other products of this valuable principle of drawing, and still there is very little in print, so far as the writer has observed, in relation to it. That wire rods, produced ready for drawing by different processes, such as casting, rolling, slitting from sheet, etc., are drawn into wire by pulling through dies, is about the extent of the general information on the subject. The wire drawer, with his methods for preparing the dies, lubricating or furnishing the necessary coating, or interposed substance between the walls of dies and surface of metal passing through to prevent abrasion, has been singularly reticent; but the work of improvement in wire drawing has gone steadily on, until the accuracy with which exact size, roundness and superior finish can be reached, as compared with the best it was possible to get a score of years ago, makes it apparent that while little has been given out to the public in relation to this important industry, it has been fully keeping up with the times.

From one writer on the subject, whose work, "Wire: its Manufacture and Uses," I feel fortunate in possessing a copy of, I read that so-called wire has been traced by good authorities back to the period of early Egypt; and that gold wire, metallic shreds, have been actually discovered that date back to 1700 B. C., but these were not drawn wire; and from the same authority we learn that wire drawing proper, dates back only to the fourteenth century, originating in Germany, and not until about the years from 1500 to 1565 did this important industry reach France and Great Britain, while here in the United States it is said to have not gained a permanent footing until 1830 or thereabouts.

That one of the pioneers in wire drawing is reputed to be doing a business of over $10,000,000 yearly, will give some idea of the magnitude to which the industry has grown. From the same authority quoted above, published in 1891, I quote as follows:

"The Western Union Telegraph Co., of U. S. A., has 648,000 miles of wire in their system alone."

Drawing in these modern days is applied to such sizes as can hardly be called wire, for shafting up to several inches in diameter, is drawn with equal facility. In comparatively large sizes, the primitive methods in which a single die is used in connection with the block around which the wire is coiled as it is drawn through the die, or the draw-bench, in sizes too large to coil, are in general use and are likely to continue to meet all requirements; but in fine wire drawing there have been, during the past ten years, several continuous wire-drawing machines invented, by use of which, as the name implies, wire in passing from reel to block, passes through a succession of dies, thus expediting the operation of reducing from a larger to a smaller size, as in place of using ten different blocks to reduce from No. 16 to No. 26, provided the reduction must be made on a given amount of wire in a given time, the one continuous machine with ten dies, through which the wire passes back and forth from the reel to the block, or drawing drum, performs the operations simultaneously of drawing from the original size to next number smaller in the first die, to the next number in the second die, and so on down to the smallest; the wire in its passage going over and around drums, which by frictional hold upon the wire, draw it from one die to the next, and so on through the entire number; and when it is considered that this continuous machine, doing the work of ten blocks, can be made to occupy but little more space than one or two single blocks, the advantage must be obvious. In fact, as stated incidentally to the writer by a fine wire drawer who has abandoned the old method for the new one, "More work can be done with one continuous machine, with a girl to tend it, than was done formerly by six men on single blocks."

Much has been accomplished since the original conception to improve the continuous wire drawing machine, both in this country and abroad, in improved methods for lubrication, arrangement of the succession of dies relative to other parts to afford means of "stringing up," *i. e.*, passing the wire through the dies to commence drawing with greatest facility possible. Some machines have been built with cylinders drawing the wire through each die separate from the others, and running at varying speeds arranged to undertake to compensate for the more rapid elongation of the wire as reduction progressed to smaller size; others in which plain cylinders are used and no attempt is made to compensate for varying longitudinal travel of the wire, but it is permitted to adjust itself in this respect by slipping on the cylinders. Others still have used grooved cones with a view to meet the situation by the different peripheral travel of the different steps in the cone.

In England the continuous wire-drawing mill invented and patented by Alfred and Thomas Bolton, has come to be recognized as a very effective machine, and several of them have found their way into the hands of wire manufacturers in this country, while here in Waterbury the Waterbury Machine Co. referred to above, have built several different machines of this type, on which they hold patents; and recently, I am informed, they have acquired the exclusive right for the United States to build and sell machines under the Bolton patent; and with this machine, the effectiveness of which has been fully demonstrated, added to their already wide range of wire drawing machinery, they will be able to furnish a complete outfit in this line.

When it is considered that much fine wire is drawn from rods of from three-sixteenths to one-quarter inch diameter, and that the amount of the elongation may be from six to ten feet in a pound, to as many miles, the value of the continuous wire-drawing mill must be apparent, and there are well authenticated records of over a hundred miles of wire having been drawn in a single piece!

* * *

Some of the arguments against such refinements in machine tools as the thread-cutting devices without changing gears, are about as sensible as those against the stem-winding watch, which declared it would wear out sooner than the old key-winder. The difference in length of service hardly offsets the time saved and the convenience of the improvement.

* * *

NOTES BY A ROVING CONTRIBUTOR.—2.

MORE ABRASION—THE PROFESSOR'S VIEWS—TO TRIM CAST IRON WITH A FILE—APPLICATION AND SHEKELS—CORNISH ROLLERS—GRINDSTONE FRAMES; MORE ABOUT THESE—EMERY WHEELS IN A MODERN SHOP.

I have just received the following from the Professor, an unexpected honor:

"Your notes on abrasion problems are good; I had never thought of the subject. It is commonplace, however, and you certainly do not expect me to go rummaging around grindstones for you or the editor, even. Common people pursue these things in the way of gain. I hope what you say is true, except that portion reflecting upon pure science. This I cut out and the editor put it back, writing 'stet' in capitals. Abrasion is not amenable to mathematics, inductive or deductive analysis of any kind. It is vulgar and non-professional. Quit it as soon as possible.

"The Professor.

Here is the old story; I have not fairly started into abrasion yet, and am going right on. Only yesterday I detected a man wandering away outside common practice. He had a piece of cast iron in a lathe, set an old file with one end down on the lathe carriage, put the but of a tool against the file and forced the flat face against the casting. I thought he was a fool, but it turned out otherwise. That flat file took hold like a gas-pipe on a grindstone, and a stream of iron sand poured out below. The

iron torn off was more than could be cut with a tool. I asked questions and got answers as follows:

"I often do that. An old file is as good as a new one. Don't matter which end's up. Sometimes it won't work; don't know the reason. Always takes hold on soft iron; won't work on anything but cast iron. It is the same thing, I reckon, as 'chawing' out a bearing."

I believe it was the same action as that between a soft tool and a grindstone; a lodging of the loosened particles in the grooves of the file, where they were more firmly held than those in the mass and became displacing implements. Here is where the Professor should come in, but he is of no use anyway as a first reference. It is like the old proverb. The Germans suggest, the

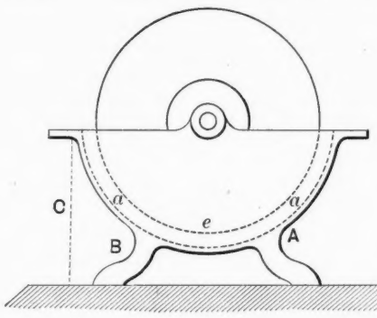


Fig. 1

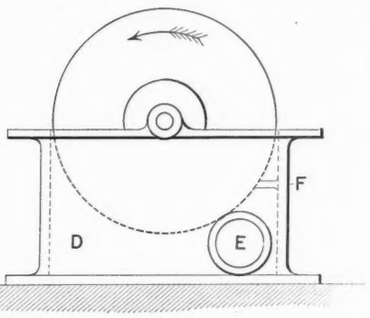


Fig. 2

French classify, and the English "apply." To paraphrase the renowned Captain Cuttle, "The shekels lie in the 'application.'" The Professor does not know anything about shekels, and it is better that he don't, perhaps. His wife draws for him a liberal salary and provides vesture, food and shelter. What has he to do with "application" and shekels?

Going further into this abrasion problem, is there not some peculiar action where the particles of friable material will become the agent of their own removal? Is not this, if so, capable of extended application in the arts as a means of shaping or removing surplus material? A pair of Cornish rollers, for crushing quartz, if made of hard metal, chilled, for example, will wear out twice as soon as if covered with a hoop of soft iron. The reason can be "seen," but not explained. The soft iron cannot be seen because it is covered with a layer of quartz sand imbedded in and upon the iron so as to protect it. This is what it looks like: When the surfaces meet normally, as in pounding a hard stone with a soft hammer, the metal surface becomes coated with the material. Abrasion ceases, or nearly ceases.

The seizing or cutting of bearings belongs in this category. Hardened steel will seize if exposed dry to high pressure. Old millwrights know how "steps" are sometimes "welded" to the end of a vertical shaft; a stone spindle, for example, but more often of the main transmission shaft to drive the dressing and auxilliary machinery—welded until they must be heated and cut off. "The interlocking of particles," says the Professor. Perhaps so, but under what conditions and how controlled?

Getting down to grindstones again, these useful implements are commonly trussed up like a cheese, in a case that fits their contour as in Fig. 1. Why, in the name of all the saints, is the frame contracted at A and then spread out again at B; to gain stability? Why is a pattern made that costs twenty to forty dollars, when a better one will cost but ten or fifteen dollars. Just look at the beastly contour of the thing; an imitation of a flower vase, to hold a grindstone! But æsthetics aside, look at the utility of the matter. The semi-annulus *a* will hold a few quarts of water and slime, that are thrown out instantly as soon as they rise to the stone at *e*. If a tool is dropped or dragged in, a common occurrence, and the stone is not jammed thereby, the man goes to the tool room for another; that tool is done for until a new stone is to be hung and Pat gets the old tool out of the mud, to be thrown among the scrap.

Now look at Fig. 2, a plain sensible box. Well footed, solid, sensible and cheap. Room for a barrel of water at D. A handplate at E to take out tools, also the slime. A hint is enough to the wise. I have seen both kinds of these grindstone boxes and ground at them. Also paid for patterns of both kinds, and have sold No. 2 to a man who said he bought it expressly to have the privilege of putting a No. 1 in the cupola. It had turned over every time the belt was taken up, wound the belt around, hoisted the whole rig up to the main shaft, wounded a boy that cost $200 to repair, slushed the shop regularly and was a nuisance.

We do not make the frame just like No. 2. The hole E was dual, one in each end, held by clamps and a comfort in all ways. There were other little dodges about the machine, but I have explained enough here. If anyone wants a proper design they can send to the editor, who will generously give away my time to make one. I once presented this matter to the Professor, as an illustration, and he remarked: "The kinetic stability of revolving mass must be taken into account in connection with elements to compensate its gravity." I got away as soon as possible at this point.

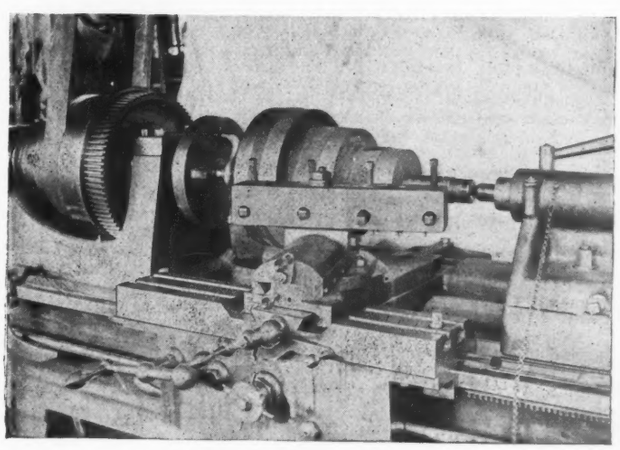
About a dozen years ago it was all at once discovered by the makers of emery-wheel apparatus that their wheels, properly mounted, were much better than grinding-stones for general shop purposes, and by the usual methods convinced a good many people, who provided outfits of this kind. Eight years ago I visited a shop where this system had been fully introduced. Eight days ago I was in the same shop and found the old regulation grindstones back in their place again. The foreman said: "All of our nice grinding has gone to the tool room now, and emery wheels are no good for rough work."

By "no good" he meant mainly, without knowing it, that men are not accustomed to emery-wheels. These are only twenty years old against two thousand years for grindstones, and lack two ciphers of age. Sometime shopmen may use dry or wet emery-wheels for the purposes of a common grindstone, but it will be too late to be announced in these notes.

* * *

CONE TURNING FIXTURE.

The cone turning fixture shown in the cut and used in the shop of the Meriden Machine Tool Co., Meriden, Conn., consists of a plain rectangular piece of cast iron, with holes drilled through it at such an angle as to give a proper rake to the top of the cutters. When the rest on which it is clamped is swung around as shown to accommodate the steps of the cone, it brings the cutters, which are pieces of square, self-hardening steel, into such a position that they will cut either across the face, or outwards to square the faces. The cutter shown at the right, which in its present



CONE TURNING FIXTURE.

position is not doing any work, will, when the others have cut across the face, be in the proper position to square the small end of the cone.

The holes being round will take almost any size square steel, and the set screws bring the corners solidly against the cast iron, no matter what the size of the steel (provided, of course, that it is not very much too small for the hole), and by making the sizes so the cutters are free to move when not clamped by the set screws, they are very easy to adjust, or to take out for grinding. Incidentally the round hole is the cheapest possible construction.

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SEPTEMBER, 1896.

IMPROVED tools and methods have of late years very greatly reduced the cost of machinery in this country, and the prevailing low ocean freights now enable American manufacturers to deliver their product in any accessible part of the world at prices that make it practicable for foreign manufacturers to use the labor-saving appliances for which this country is famous. All manufacturers, regardless of where they are situated, who desire to reduce the cost of their product, should communicate with makers of American machinery or their representatives.

TWO AND TWO MAKE FOUR.*

The silver question will be settled by the votes of the men who work—whom Abraham Lincoln called the "plain people;" upon whom every industry is dependent, directly or indirectly, for its support. When they are idle, business stagnates throughout the country; when they are earning good wages, business prospers. Our business is no exception to this rule, and if for no other reason than this we are opposed to any political or financial policy that injures wage earners and in favor of any policy that helps them.

Many exponents of both sides of the money question have little except theories to offer in support of their belief; and as one man's opinion is just as good as another's, and ours no better than the next one's, unless supported by facts, we shall in this article say as little as possible that cannot be supported by figures accessible to any one who cares to look them up, and from which a conclusion may be deduced that is as plain to any thinking man as the conclusion that two and two make four.

The United States gold dollar contains 23.2 grains of gold, and this is the unit of value by which all our money is now measured. Free coinage at sixteen to one means that sixteen ounces of silver shall be made by law equivalent to one ounce of gold for the payment of all debts, public or private; and that 412½ grains of silver, now worth about 53 cents, can be brought to our mints from any part of the world and coined into a dollar without expense to the owner. Based on the present market value of silver, about 31 ounces of silver are required to equal in value one ounce of gold; that is, silver is now worth 66¢ an ounce and gold $20.67 an ounce, so that free coinage means that for a little more than half its actual value in silver, the United States Government shall give back to its owner a silver dollar, with which he can buy from you the same amount of labor that you now get one hundred cents in gold, or its equivalent, for.

The silver advocates do not deny this fact, but they claim that free silver will cause the prices of everything to advance, including labor, and that this general advance will bring prosperity to the country. This is simply a theory which has all the actual facts against it; and every skilled workman knows what a wide difference there usually is between a theory and the actual result worked out therefrom. He knows that when a man starts a piece of work he goes about it in the same way that he has done a similar piece before, for his experience tells him what the result will be. This does not mean that methods we are all familiar with are not being improved every day; but it does mean that they are being improved by the application of common sense principles which an intelligent man can see the reason for, and not by untried theories which are opposed to all obtainable experience. The same common sense rule should be applied to the money question.

In all the free silver literature that has been put forth we have not been able to find one valid argument in its favor, based on practical experience. There is an abundance of claims, theories and high sounding metaphors like the familiar "Cross of gold"; but the mass of wage earners in this country are intelligent men who want something more definite than metaphors before they change their opinion upon a subject of such vital importance to them as MONEY.

Following are the principal free silver claims and theories, placed side by side with facts and experience; and don't forget that every figure and statement given below, unless otherwise specified, is taken from official reports, the accuracy of which is unquestioned:

* We propose to print and circulate among working men one million copies of this article in leaflet form, through our agents and correspondents. Those who are willing to help this work may obtain copies at the nominal price of ten cents a hundred, postage prepaid. Anyone who does not feel able to send us ten cents for one hundred, may have twenty-five for the asking, provided only that he agrees to distribute them.

CLAIMS AND THEORIES.	FACTS AND EXPERIENCE.
That what the silver men now call the "Crime of 1873" was a conspiracy on the part of the gold bugs to withdraw silver from circulation and contract the currency.	In 1873 there was neither gold nor silver in circulation in this country, nor did either begin to circulate till 1879. The *money* in circulation has constantly been increasing. In 1860 the amount was $442,102,477; in 1872, $738,309,549; in July, 1896, $1,509,725,200. The so-called "Crime of 1873" consisted in the passage of a law *which had the special support of the Senators and Representatives of the silver states*, omitting from the coins of the United States the standard dollar, but continuing the coinage of the fractional parts of a dollar and providing for the coinage of "trade dollars," containing 7½ more grains of silver than the standard dollar. 55,965,924 of these "trade dollars" were coined. In 1878 the Bland-Allison law was passed, which required the Secretary of the Treasury to purchase and coin into dollars not less than $2,000,000 nor more than $4,000,000 worth of silver bullion per month. $308,279,260 worth was bought under this law. In 1890 the Sherman Silver Purchase Act was passed requiring the Secretary of the Treasury to purchase silver bullion amounting to 4,500,000 ounces a month, and to issue for it Treasury notes, payable in gold or silver at his discretion. $156,000,000 worth of silver was bought under this law. The total number of silver dollars coined prior to 1873 was 8,031,238; the total number since 1873 is 430,790,041. The loss to the country on the purchase of silver bullion since 1878 amounts to $145,871,952. *Haven't we done enough for silver?*
That the shrinkage in prices during the last twenty years has been caused by the diminishing amount of money in circulation in this country.	The money in circulation in the United States has steadily increased during the last thirty years as follows: 1865... $714,702,995 | 1885..$1,292,568,615 1875... 754,101,947 | 1890.. 1,429,251,270 1880... 973,382,228 | 1895.. 1,601,968,473 The per-capita circulation increased from $18,70 in 1872 to $24.33 in 1894.
That this shrinkage in prices has injured the working man.	A shrinkage in prices is an advantage, not an injury to the wage earner, so long as his wages do not fall. Whatever increases the *purchasing power* of his dollars helps him. In other words, if he is getting a dollar a day while food and clothing fall in price one half, he can buy with his dollar just twice what he could before; so that he is practically as well off as if his wages had been increased to $2.00 a day. The contrary is, of course, true if the *purchasing power* of his dollar shrinks. If he is paid in dollars that will buy but 50 cents worth of food, etc., his wages are practically reduced one half.
That the wage earners have been growing poorer and poorer since the adoption of the gold standard in 1879.	The savings bank deposits in the United States have increased from $802,490,298 in 1879 to $1,041,867,500 in 1895.
That free silver will make the working men prosperous.	The savings banks of this country hold $1,041,000,000 in the savings of wage earners. *There are no savings banks in any free silver country.*

CLAIMS AND THEORIES.	FACTS AND EXPERIENCE.
That the United States has less money in circulation per capita* than other countries, especially the silver countries.	Below is given the per capita circulation of the following countries on January 1, 1894, the latest accessible date: United States.24.33 | Servia..... 3.95 United Kingdom.....19.98 | Austro-Hungary ..... 9.19 Germany ....18.78 | Netherlands..25.53 France.....36.70 | Norway..... 6.55 Belgium.....25.98 | Sweden ..... 5.79 Italy..... 9.63 | Denmark ....11.36 Switzerland. .16.06 | Turkey..... 2.29 Greece. .....20.68 | Bulgaria. .... 1.76 Spain .....17.89 | Australia ....23.83 Portugal.....25.36 | Egypt.....19.85 Roumania.... 6.34 | Cuba ....12.19 The silver countries are: Mexico..... 4.71 Central American States. ..... 3.78 South American States*..... 17.22 Japan..... 4.09 China..... 2.08 Russia..... 8.31 * Some of these are on a gold basis.
That wages have decreased since the adoption of the gold standard (1879).	The committee of the United States Senate which thoroughly investigated this subject in 1894, reported that in 21 selected industries, wages were 40 per cent. higher in 1880 than in 1860, and 60 per cent. higher in 1891 than in 1860; while the prices of staple articles had in many cases fallen one third.
That under free silver, wages will advance in the same proportion as food, clothing, etc.	Between 1860 and 1865, when gold went to a premium, as it will now if free coinage becomes a law, the average price of all articles in this country advanced 116 per cent. and the average increase of wages was only 43 per cent., although during that time 2,800,000 men were withdrawn from the working community to serve in the army, which caused a scarcity in the labor market that alone accounts for a part of the rise. As there will be no such withdrawal of labor at this time, the increase would undoubtedly be less than it was then. The Mexican laborers have always been paid in silver. In 1870 their dollars were worth $1.10 in gold; now they are worth only 53 cents. Their wages remain the same, but their purchasing power has decreased one-half. That is, they can get only half as much food, clothing, etc., for their labor to-day, as they could in 1870; and this has been caused entirely by the depreciation of the money they were paid in. If they had been paid in gold, or in money that was equivalent to gold, dollar for dollar, they could get more for their labor, because nearly everything is cheaper than in 1870. The relative wholesale prices of a few articles of common use are given below. The same difference holds good throughout a long list of staple articles:

	United States.	Mexico.
Bacon, per lb....	$0.12	$0.32
Ham, per lb.....	12	32
Salt, per sack....	40	90
Beans, per lb....	3	17
Sugar, per sack..	5.50	10.75
Flour, " " ..	2.25	8.50
Tea, per lb	35 to 90c.	70c. to $1.50

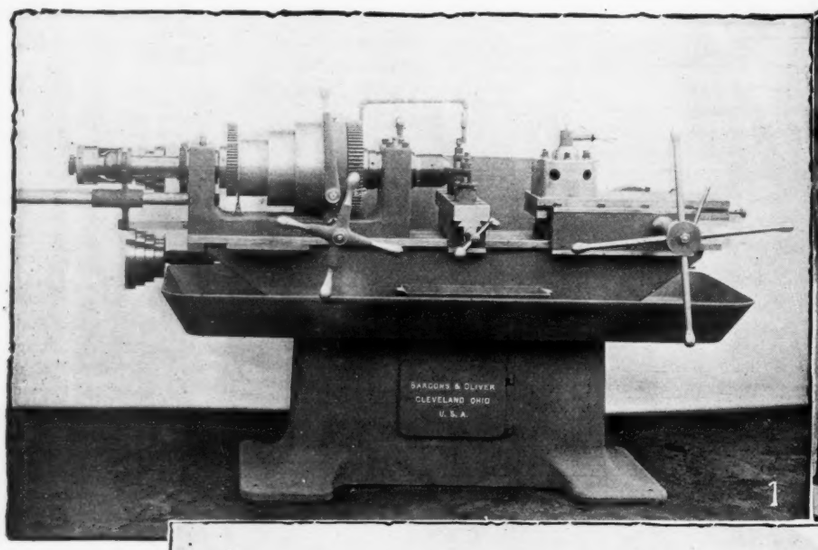
That the Government can make fifty-three cents' worth of silver equivalent to one hundred cents in gold when the amount of the former metal in circulation is unlimited.	A twenty dollar gold piece is worth one hundred cents on the dollar anywhere in the world, because the value is represented by the gold in the coin, irrespective of the stamp of the Government, A silver dollar, the silver in which represents a value of fifty-three

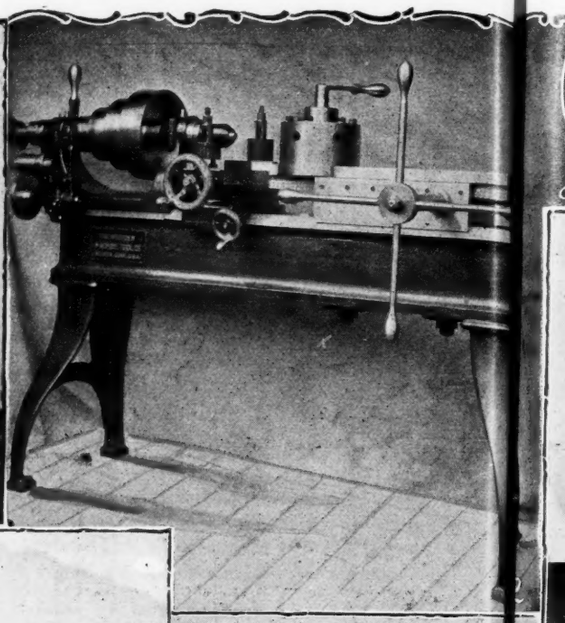
* Literally PER HEAD. The total amount divided by the number of inhabitants (heads).

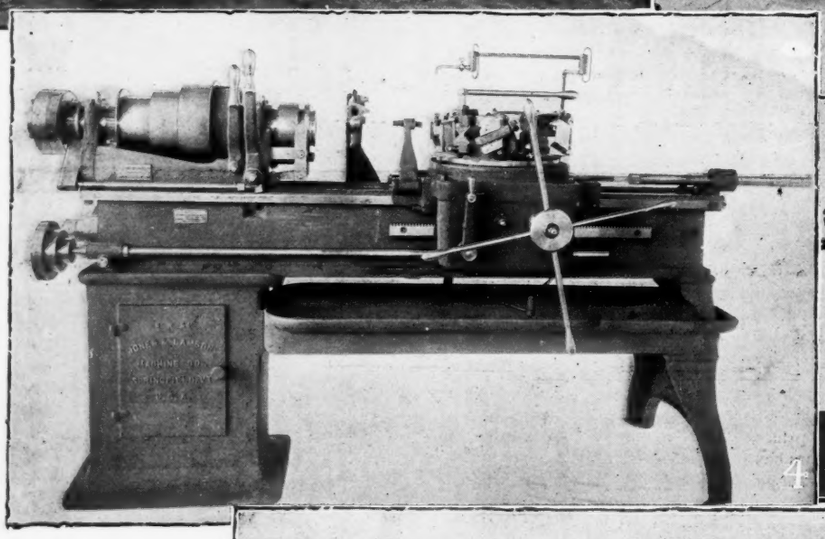
Concluded on page 29.

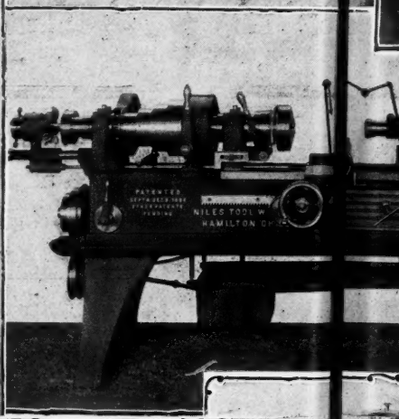
TURRET MACHINERY.

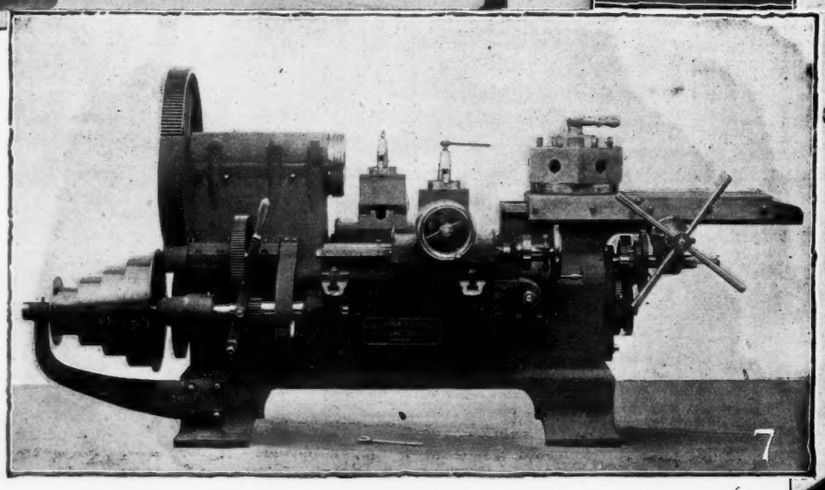
No tool has worked greater changes in the methods of shop work than the turret lathe, and the ones shown herewith give a very good idea of the variety of kinds and sizes that are in use to-day. The work they do varies as widely as the sizes and weight of the machines themselves, and a practical contrast is seen in numbers 7, 8 and 9; number 8 being a light screw machine, and its neighbors heavy machines of many times its weight. We believe this method of illustrating leading tools will do much toward making the mechanic more familiar with modern shop practice. A general idea of each machine is given and further information can be obtained from the various makers.











BARDONS & OLIVER, CLEVELAND, O.

The machine shown is the No. 5 of this firm's make, being a rather heavy turret lathe equipped with friction back gears, which, by the way, save more time than many imagine. The column support is a feature which is not generally used, and is rather novel on this account. This form of support is said to give greater solidity than the leg generally used, and aids in maintaining proper alignment of turret and spindle under all conditions. This machine also has a very deep oil pan, which is a desirable feature. The head-stock is of rigid design and the heavy uprights insure long bearings, which are well supported.

Their method of operating the wire feed brings the small pilot wheel near the operator, which is very convenient. A patent has been applied for on this feature. The oil guard at the back prevents the usual oil bath on the floor, saving both oil and profanity.

For brass work they make a turret on legs, so as to allow a box beneath to catch work, as is often desirable. A few words in a letter from this firm may give several hints on machine design:

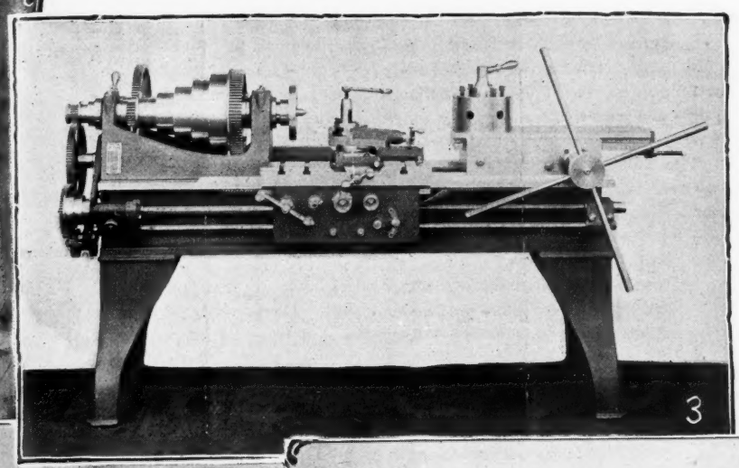
"We make a special point in designing them, to cut out every

1 BARDONS & OLIVER, Cleveland, Ohio.
2 MERIDEN MACHINE TOOL CO., Meriden, Conn.
3 SPRINGFIELD MACHINE TOOL CO., Springfield, Ohio.
4 JONES & LAMSON MACHINE CO., Springfield, Vt.
5 NILES TOOL WORKS, Hamilton, Ohio.
6 WARNER & SWASEY, Cleveland, Ohio.
7 LODGE & SHIPLEY MACHINE TOOL CO., Cincinnati, Ohio.
8 BROWN & SHARPE MFG. CO., Providence, R. I.
9 GISHOLT MACHINE CO., Madison, Wis.

line and corner that does not mean something, or in other words, that has not something to perform. We subordinate the idea of beauty entirely to that of utility, and have endeavored to tear ourselves entirely away from all forms of architecture, either Gothic, Ionic or Doric. To our minds any line, curve or corner that has no duty to perform, and that does not contribute to the successful working of the machine, is an eye-sore."

BROWN & SHARPE MFG. CO., PROVIDENCE, R. I.

The illustration shows the No. 1 screw machine of this firm, and is one of the best known of its type. It is a small machine, the hole through spindle being but $\frac{17}{32}$ inch in diameter. The spindle is steel, hardened at bearings, and runs in bronze boxes.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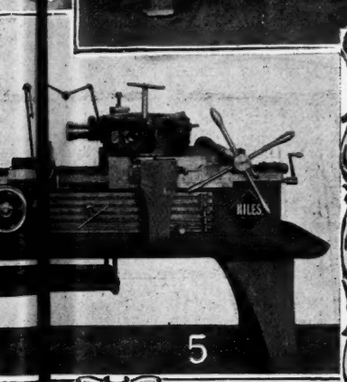

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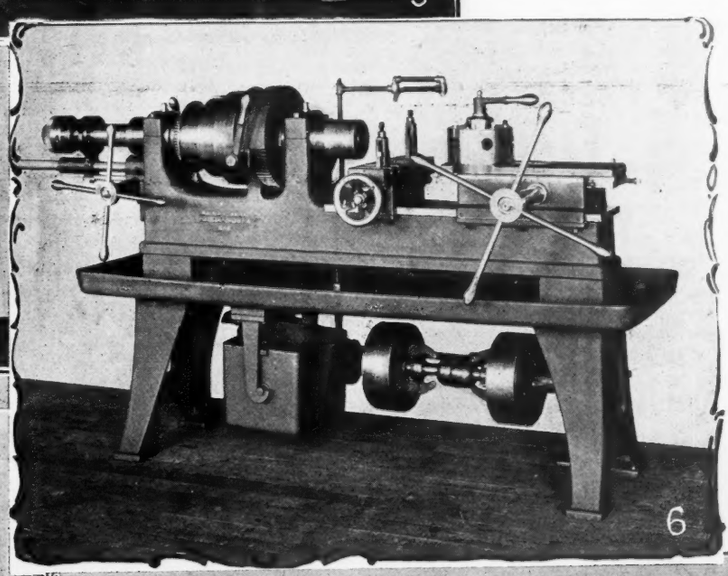
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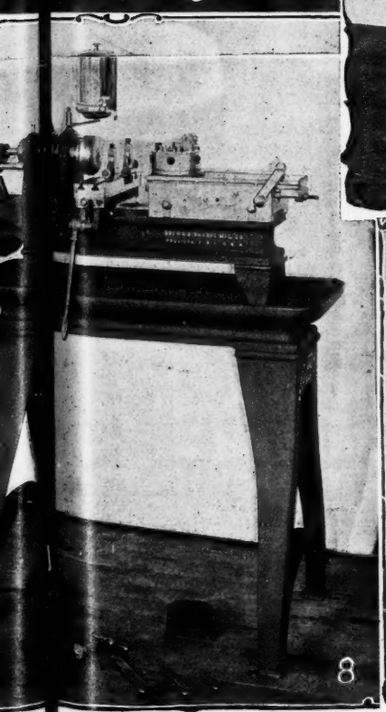
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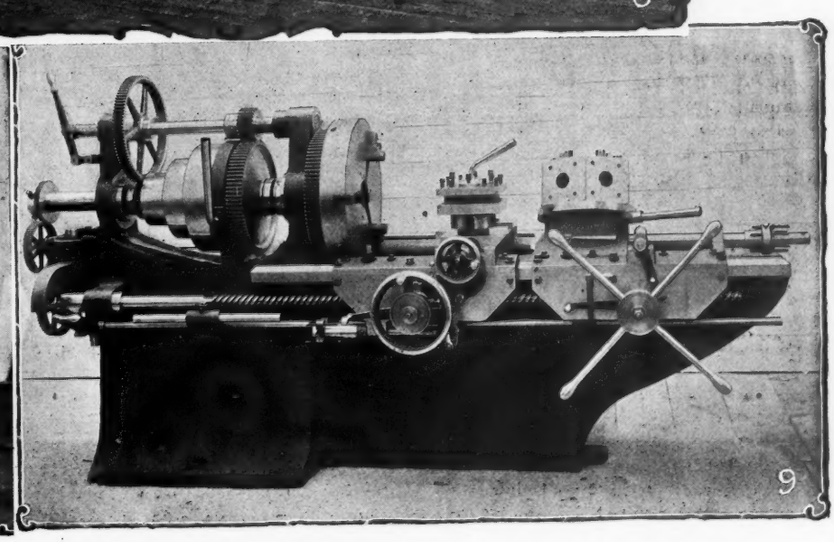
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It has a chuck and wire feed, which is automatic in action and is very rapid. The chuck opens, the rod is fed forward and the chuck again closes within one second of time, this being accomplished by the operator pressing and instantly releasing the small lever on the front of the head-stock; about as practical an application of "You press the button, we do the rest," as we know of. The feed is readily adjusted to the desired length, and any multiple of it can be obtained by repeated pressure on the lever. The maximum feed by one movement of the lever is 2 inches.

The turret has six holes $\frac{3}{4}$ of an inch in diameter, the center of holes being $1\frac{1}{2}$ inches above top of slide; greatest distance between turret and front of chuck, $7\frac{3}{4}$ inches. The swing is $9\frac{1}{4}$ inches over bed, $3\frac{7}{8}$ inches over slide rest. Can turn a piece 3 inches long. The tool post is of new design, the tool being adjusted by screw and wedge, making it much easier and quicker to set up a machine for any work. The tank table has a reservoir cast in bottom for collecting the strained oil.

GISHOLT MACHINE CO., MADISON, WIS.

This shows the standard friction head machine of this company, and it may be said that this machine was a marked departure from existing practice when it appeared several years ago. The bed, head-stock and all brackets are cast in one piece, securing great rigidity, a necessary qualification for heavy machine work of this character. All wearing surfaces are large and in keeping with the rest of this heavy and rigid machine. The turret is of the hexagon type, large and heavy, and provided with tapped holes for bolting large tools to faces of turret. The turret carriage slides directly on the bed, and has the full traverse of the bed, which permits the use of long boring bars, the outer ends of which may be supported in a bushing in the chuck, adding greatly to its stiffness in the work.

The main carriage carries a square tool-post, capable of carrying four tools, so that either one may be used at will, each tool being independently adjusted as to height. Dead stops are provided for each tool in the tool-post and each face of turret, and they are all independently adjustable, which gives the machine great range for duplicate work of a heavy character. By a novel arrangement of the feed mechanism, four changes of feed can be instantly obtained, either from the end of the machine or from turret slide. It can also be instantly reversed. A study of the engraving will show many noteworthy points of design which can be remembered to advantage.

When supplied with an outfit of tools it can handle such work as cone pulleys, Corliss engine bonnets, large sized valves and similar work.

This, in a measure, takes it out of the realm of a "special tool," and makes it, as well as others of its class, an almost indispensable part of a modern shop equipment.

JONES & LAMSON MACHINE CO, SPRINGFIELD, VT.

This machine can safely be called one of the most marked departures from existing practice that has been seen in the machine line for a number of years, and its designer, Mr. James

Hartness, is to be congratulated on its success, both mechanical and financial. Its best work is done with pieces not over 2 inches in diameter nor over 24 inches long, although this is not its limit. The carriage which carries the turret is gibbed directly to the bed and is fed by power or hand as desired.

The turret is simply a flat circular plate, gibbed at its outer edge and having the locking pin directly under the tool which is at work. The tools bolt direct to the flat turret plate and hence have no overhang. All the required stops are provided as a matter of course. The turret turns only to place desired, and travels just the distance required by the tool at work. The back gear is controlled by friction clutch, and can be varied from 4 to 1 with the regular, to 16 to 1 with the triple gear. A three-point bearing is provided for the bed, which makes it practically impossible to twist the bed by irregular or unsteady foundation. A triple counter-shaft is provided, containing three friction pulleys, two of which run at 300 revolutions per minute, the other at 150 revolutions, giving a wide range of speed. A convenient feature is that they are all operated by one shipper rod, so that the operator can change his speeds at will for turning or tapping, as the case may be.

LODGE & SHIPLEY MACHINE TOOL CO., CINCINNATI, OHIO.

While this machine is rather a side issue with its makers, it possesses enough novel features to warrant its reproduction here. It is a double saddle turret, having 30 inches swing and 26 inches between the head and foot-stocks. It was designed for such work as gear blanks, pulleys, couplings and similar pieces, and handles them rapidly and accurately. The frame, including the head-stock, the ways on which the rails rest, and the foot-stock, is cast in one piece.

The spindle is 6 inches in diameter, has a 3¾ inch hole the entire length, the front end being bored taper to receive a center or bushing. The nose is 9¾ inches in diameter and threaded to receive face-plate or chuck. The spindle is driven from the main driving shaft by a train of six gears (which includes the back gear), the ratio between driving shaft and spindle being two to one and thirty to one, with the back gear out and in respectively. This gives a range of eight speeds from 2 to 180 revolutions per minute. The power is taken from a 3½ inch belt to a four step cone on main driving shaft.

The feeds are all by gears and are on the same principle as an engine lathe. The saddles are driven by a combination of bevel and spiral gears and friction devices. The rails also move to and from the center and swivel. Tool-blocks carry one or more tools as desired. Power cross feed to the front saddle as well as a geared crane for heavy work, are furnished when desired.

This lathe can be adapted to almost any class of duplicate work and its uses will be apparent to any modern shopman.

MERIDEN MACHINE TOOL CO., MERIDEN, CONN.

This lathe is an outgrowth of the Meriden Machine Tool Co's. forming lathe, which was at first made for forming (turning ornamental or specific shapes or forms) only, and had no turret, but was provided with a foot-block (tail-stock), principally for supporting the ends of long pieces. With the extension of the use of the forming lathe a demand came for a turret, which was added as an auxiliary. There are no very special points about the turret part itself. It is of good design and construction, the lock bolt is rectangular in section, is (on the 18 inch lathe) 12 inches long, backed by a spring 12 inches long, and engages with the index ring almost directly under the tools; it is also supported on both sides to its full height so there is no twisting, making the turret very rigid when locked.

Then came a demand for a turret lathe with some of the convenient features of the forming lathe, and the difference between the lathe shown and any good conventional turret lathe is represented by these features, which show plainly in the picture.

The lever shown at the left for operating the chuck is nearer the operator, and has an easy and natural forward motion, instead of being inconveniently far away to the left and having a hard and side straining motion. The other feature is the small wheel shown at the lower right hand corner of the cut-off slide; this actuates a longitudinal feed, and in addition to being a great convenience and time saver on setting up for a job, is useful for jobs of long knurling, or facing a joint; and in short, as it gives the slide all the motions of an engine lathe carriage or a slide rest, its great usefulness being apparent without further description.

NILES TOOL WORKS, HAMILTON, OHIO.

This lathe takes in work up to 2 inches in diameter by 24 inches long, and is solidly built, weighing about 5,000 pounds. The speed can be instantly changed from cone to back gear. It has automatic stock feeding mechanism which takes in all sizes of round, square or hexagon stock without adjusting, being always ready and requiring no change, and feeds *forward*, no matter in what direction the lathe is running.

The chuck is strong and the jaws are opened and closed by power throughout their entire range from ½ inch to the full opening, no collets being used, and is so constructed as not to withdraw the stock from the gauge in closing.

The feed is by a central screw directly under the work. Both the turret and carriage can be fed in either direction simultaneously, thus letting two or more tools be operated together. The turret has automatic adjustable feed stops for each tool and will operate when feeding in either direction. These adjustable stops are placed in front of the machine, where they are entirely free from chips and dirt, and are readily and quickly adjusted.

The turret is so constructed that long work can pass through it without interfering with the action of the tools. The entire turret equipment can be used without interference. Chips and dirt are separated from the lubricant and only clarified oil is fed to the pump.

Instead of the usual cut-off, the makers have retained on this machine the gibbed carriage used on their standard screw machines, with front and back tool-posts; it is arranged with power longitudinal feed and stop motion to the tool slide. With this arrangement, cuts can be taken with the carriage tools at the same time the turret tools are in operation.

They have also retained on this machine the opening die-plate on the hinged arm, by means of which the thread is first cut before using solid die for sizing. By this arrangement of opening die plate, work is quickly backed off.

A taper turning tool with former can be furnished if desired.

SPRINGFIELD MACHINE TOOL CO., SPRINGFIELD, O.

This is one of the developments which have been demanded by the necessity for rapid lathe work, and the increasing knowledge regarding the value of a turret, made the combination an easy and natural step. In some cases, where the addition of a turret was an after-thought, its addition has not been particularly successful, as the ordinary lathe rarely has the required stiffness for this class of work. In this case the design is unusually heavy to meet the additional strain, and it can be successfully used in chucking and other heavy work. Provision is made for maintaining the alignment of turret, which is an important feature.

The turrets are made to revolve either automatically or by hand, and with or without power feed and stop. They are 9 inches in diameter, bored to receive six tools, and have a movement of 10 inches. When the turrets are made to revolve automatically, the parts subject to wear are made of tool steel and hardened, making them very durable. The spindle is threaded but two-thirds of its length, which gives the face-plate or chuck a straight bearing; this aids in putting it on and adds to its wearing qualities. Ample bearings are provided, the front journal being 2¾ x 4½ inches, the spindle having a $1\frac{5}{16}$ hole through it. The back gearing is in a ratio of twelve to one, and the machine with 6 foot bed weighs 2 600 pounds.

WARNER & SWASEY, CLEVELAND, O.

This is the latest addition to the line of screw machines of this firm, and as the one shown has a 2⅝ inch hole through the spindle and $2\frac{3}{16}$ inch through the plunger, it will be seen that it is a fairly large tool.

It will be noticed that the head is cast solid with the bed, insuring extreme rigidity and enabling the use of larger cones than would be possible otherwise. This is equipped with automatic chuck and wire feed, geared friction head, geared oil pump and all necessary piping and drips, which, together with the deep oil pan and dumping reservoir, makes one of the most complete combinations made. It is also supplied with screw feed cut-off, with an improved double friction countershaft, and all the appliances and conveniences that go to make up a thoroughly modern machine. The gears are neatly encased to keep them free from chips and also to prevent the painful and annoying accidents that are liable to occur. The turret design is in keeping with the rest of the machine and contains all the features that their experience has found to be desirable.

SETTING A SLIDE VALVE.—1.

F. F. Hemenway.

There is no intention in what follows to enter into any discussion of the merits of this or that modification of the plain slide valve or valve gear, except that it may be of interest, or of possible service, to the engineer or machinist, who in the pursuit of his vocation may sometimes be able to make, or to procure the making of, slight changes to the end of bettering existing conditions—conditions as he finds them. In the main it devolves upon the designer to plan such a valve and valve motion as in his belief will be best suited to the purpose in view, while the engineer and machinist must content themselves by keeping them in the best condition to accomplish their purpose. Doing this may well result sometimes in cutting away a little metal here or adding a little there. Whether he be authorized to do this or not, there is every reason in the world why he should speculate as to what he would do should there be opportunity. Opportunity frequently comes to those who are prepared to meet it. Not only are the engineer and the machinist interested parties, but the fireman, who does not expect always to shovel coal, is, or should be, more interested, perhaps, than either.

To serve as a text on the subject of valve setting, the slide valve has been selected because it is by far the most common type of valve in use; this notwithstanding its comparative longevity. Another reason for its selection besides that of being so well known, is because so many arguments that apply to the setting of the commonest form of slide valve apply with equal force to the setting of the more complicated forms of valves. An engineer who has made himself entirely familiar with the setting of a slide valve correctly, who has studied the logical effects of this or that modification—carries the whole thing in his head, as it were—need have but little hesitancy in wrestling with any kind of a valve or system of valves made to get steam into and out of the cylinder of a steam engine.

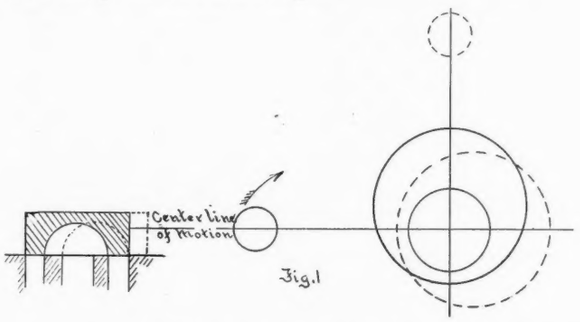


Fig. I

The primitive slide valve was without lap or lead, as represented by full lines in Fig. 1. It just covered the ports and was ready, upon the slightest motion of revolution of the shaft, to begin the opening of one port for the admission of steam into one end of the cylinder, and another port for the escape of steam from the other end. The eccentric was set in a position at right angles with the center line of motion, as shown.

It will be observed that the line marked "Center line of motion" represents that line for both the valve and the piston. By the center line of motion of these rods (eccentric rod and main rod) is meant a line above and below which they vibrate an equal distance. It is the *mean* direction of motion of the rods. If, as may be the case, one of these lines forms an angle with the other, then in speaking of the relative position of the eccentric, the center line of motion of the eccentric is to be understood.

Besides the fact that the center line of motion of the eccentric rod and the main rod are assumed in what follows to be parallel, this is a good time to say that there has been no effort to locate in any of the sketches various parts, such as the valve face, crank wheel, etc., in correct relative positions; to have done so would sometimes have resulted in confusion, and the multiplication of explanatory sketches.

In Fig. 1 the position of the eccentric at full travel forward, as well as the corresponding position of valve and crank-pin, are represented by dotted lines. It will be seen that the steam port for forward motion is fully open, and will now begin to close. which event will occur when the crank-pin has arrived at a position diametrically opposite its first or full line position, these events being repeated for the other end of the cylinder during the return stroke. One port for the admission of steam is exactly opened and closed during the forward stoke of the piston, and the other during the return stroke, the same being true of the exhaust.

Slide valves without lap or lead are not much in use to-day, although they are employed to some extent for special purposes. It is instructive to briefly refer to what may be accomplished by their employment.

The most common modification of this valve is to add outside lap, as in Fig. 2. Sometimes, but not always, inside lap is added. (This is not shown in the cut). In fact sometimes so much inside lap is given as to seriously interfere with the freedom of the exhaust. The only remedy for this is to cut away all or part of it. Occasionally more inside lap is given to one side of the valve than to the other, in order to equalize compression.

Looking again at Fig. 1 it will be seen at a glance that the position of the eccentric in relation to that of the crank-pin can-

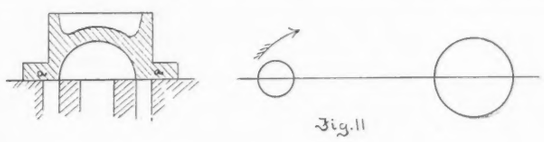


Fig. II

not be the same in Fig. 2. In both instances the crank-pin is represented as being just at the position to begin its forward stroke. In Fig. 1 the valve is also in position to begin to open the steam port for admission. In Fig. 2 the valve is not in position to do so, owing to the outside lap at *a*. To provide for this the eccentric must be advanced—turned around on the shaft—to the position represented in Fig 3; the valve is shown moved ahead by the advance of the eccentric around the shaft, until ready to open the port. A trifle further advance of the eccentric, which is generally given it, would slightly open the steam port when the engine is on "the center," which slight opening is termed "lead."

Having so far briefly glanced at a few points conveniently borne in mind in relation to the valve and eccentric positions, there being no intention to go further than this, the manner of proceeding to set the valve, Fig. 3, may be considered. No way of proceeding is the *only* way; this is *one* way. The engine is together, but nothing of the valve or valve motion is in position. Everything is cast loose, so to speak.

The first thing may well enough be to tram the valve rod, that is to locate points upon it that may be trammed from a fixed point at any time in the future when the steam-chest cover is on, and by which a knowledge of the position of the valve may be arrived at with the least possible delay. To do this use a tram *b*, Fig. 4, of any convenient length. With a sharp center punch make a mark upon some fixed part of the engine, *c*. This center punch mark is for one point of the tram. Place a *thin* piece of tin *d* in the port, as shown, and bring the edge of the valve hard up against it. With the tram, mark the valve rod accurately and on the scratch locate a fine center punch mark, as at *e*, for the other tram point. Repeat this for the other port and end of the valve and there will be two marks on the valve rod, which when in tram from the mark on *c* will indicate respectively, when the valve has begun to open the steam port at the corresponding end of

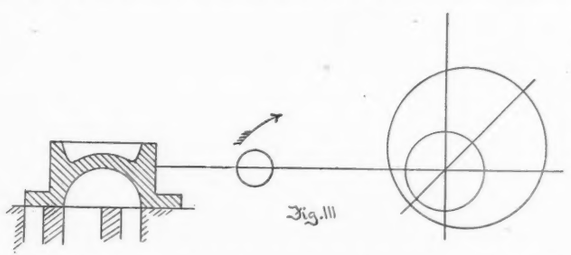


Fig. III

the cylinder. The valve can now be set as well with the steam-chest cover on as off, which may some time save considerable time in case the eccentric should slip, or some slight derangement of the valve gear occur.

Next find the approximate length of the eccentric connection—eccentric rod and valve rod. To do this, leave the eccentric loose on the shaft so that it may be turned around. Turn it around and adjust the length of the connection until the valve opens as

much port (including over-opening, if there is over-opening) at one end of the cylinder as at the other. The length of the eccentric connection thus found will be *approximately* correct. Then the dead center at the end to which the cross-head is nearest may be found, as follows*:

Move the engine in the direction it is to run until the cross-head is within about one-half inch of the extremity of its travel—the exact distance is immaterial—and from some fixed point *f*, Fig. 5, extend the tram to the cross-head and mark as indicated above *g*. Then with the same or another tram, mark the crank wheel at *f'* or *h*, as the case may be. Continue the revolution of

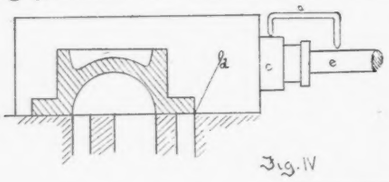


Fig. IV

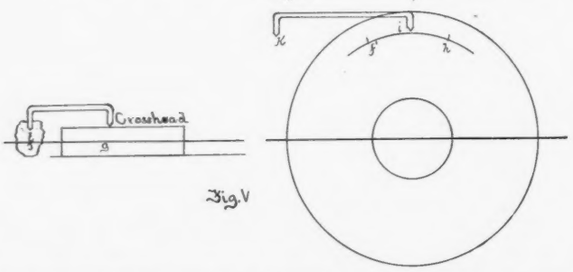


Fig. V

the engine until the center is passed and the cross-head comes back to tram with the mark at *g*. Again use the tram on the crank wheel, making another mark, *f'* or *h*. Find the exact center between these marks and make a center punch mark at *i*. When the marks *k* and *i* are in tram the engine is on the dead center. Move the eccentric to a position where the valve has the desired lead and make the former temporarily secure to the shaft.

Next move the engine to the other end of the stroke and locate the dead center there, using the same stationary tram center *k*, as before. Put the engine on this last found dead center. At this center observe if the valve has more or less lead than at the other end, and divide the lead, or the lack of lead, by accurate measurement. The manner of doing this will readily suggest itself. Thus, if the valve had $\frac{1}{16}$ inch lead at the first end tried and at the end now in hand has $\frac{1}{4}$ inch, adjust the length of eccentric connection until the lead is

$$\frac{\frac{1}{16} + \frac{4}{16}}{2} = \frac{5}{32} \text{ inches.}$$

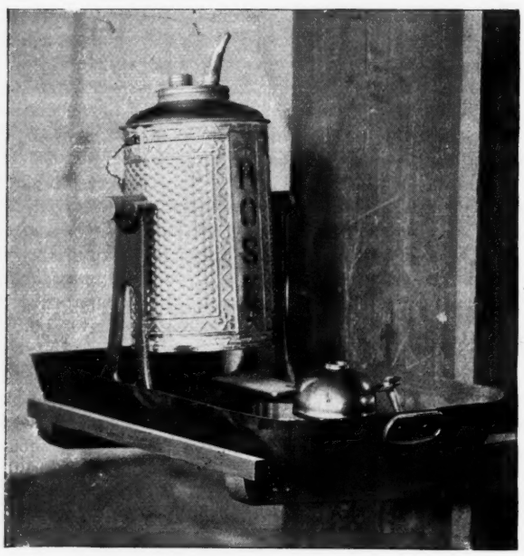
Move the eccentric to give the right lead and the valve is correctly set, that is, if the work has been carefully done.

* * *

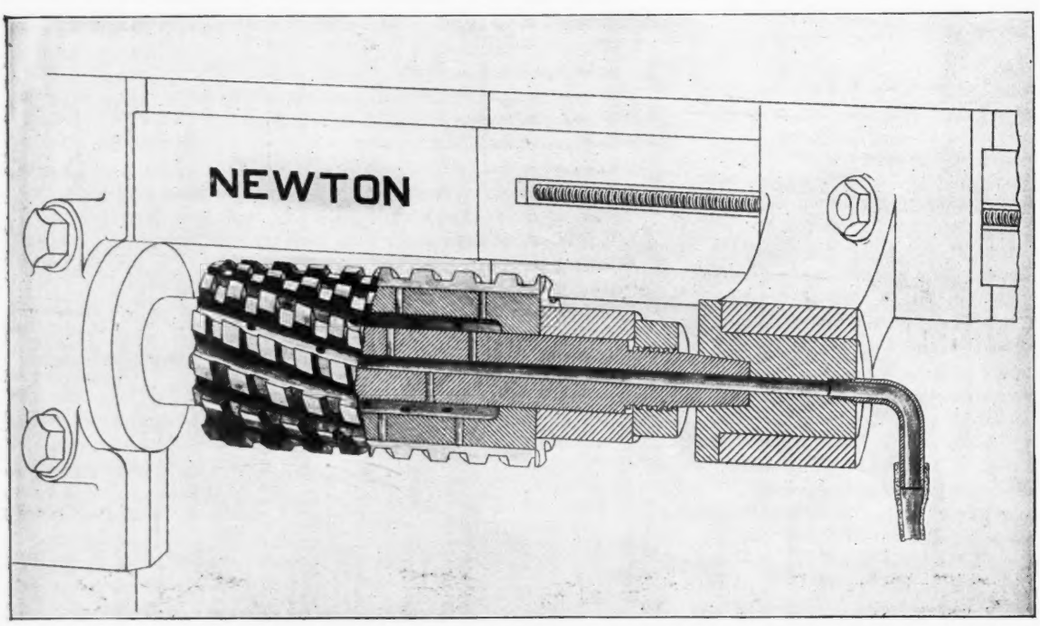
PHILADELPHIA SHOP NOTES.

S. Ashton Hand.

When looking around the shops a few days ago I ran across quite a novelty in the shape of a milling cutter for doing heavy slab milling. As can be seen by the accompanying photograph and sectional cut, the central hole in this cutter is either chambered out, leaving a fit for the arbor at each end, or is bored out much larger than is required for the arbor to go in and is bushed at each end to fit the arbor; either case proving satisfactory. With this form of cutter a hollow arbor is used having radial holes whereby a lubricant pumped into the bore of the arbor will pass out into bore of the cutter. The cutter also has a series of radial holes from the outside to the bore, thus allowing the lubricant to flow from the bore to the outside and onto the work.



FOR FILLING OIL CANS.—SEE PAGE 23.



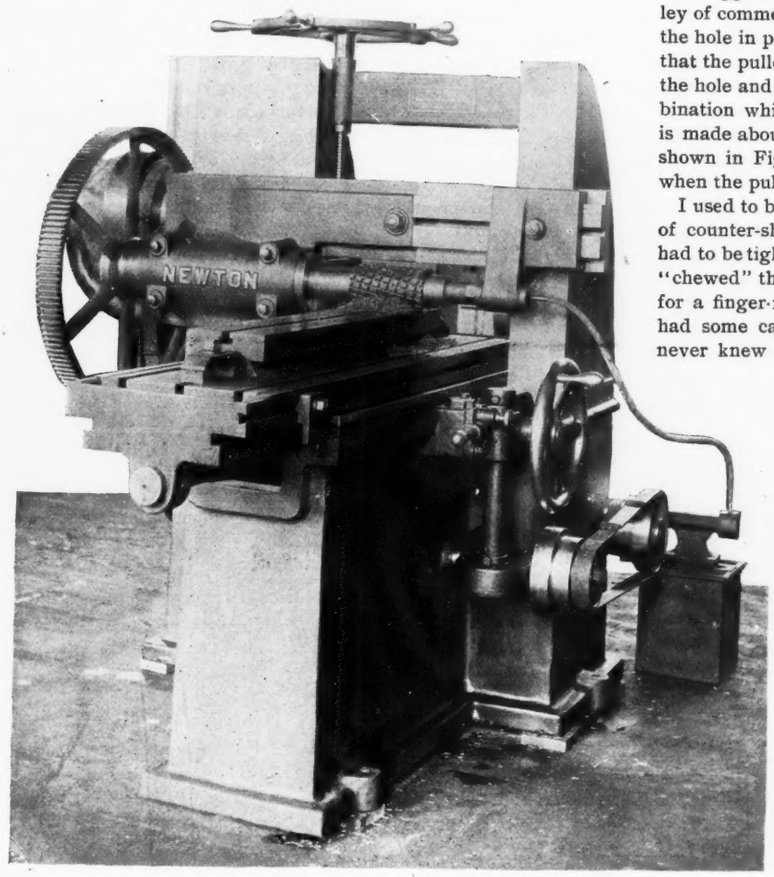
SECTIONAL VIEW OF THE INTERNALLY LUBRICATED CUTTER.

Cutters doing heavy work and lubricated from the outside will gradually become heated no matter how well lubricated, until finally the whole body of the cutter becomes so warm that it is impossible to cool it off without giving it a rest. With this new system, however, there is no very large portion of the cutter that does not constantly have a stream of the lubricant passing through it, thus allowing the cutter to be run at a much higher speed and a much heavier feed without undue heating. Another advantage is that cutters with radial holes are not so apt to crack when hardening, as more surface is exposed to the cooling medium, which tends to equalize the temperature at all parts during the cooling

* In case the engine is so small as to be easily moved from center to center, both dead centers may be found at once.

process, thus relieving the internal strains to a great extent.

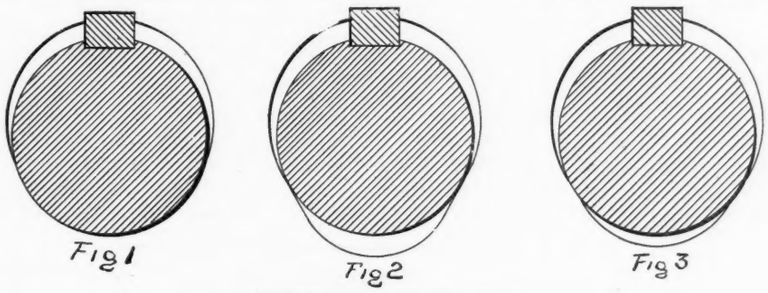
In the cut below, a milling machine provided with one of the above type of cutters is shown at work milling off the platen of a small milling machine. The cutter speed during this operation was about 50 feet per minute, with a feed of *9 inches per minute* and a cut of $\frac{3}{16}$ of an inch in depth, the cutter remaining astonishingly cool at the finish.



THE INTERNALLY LUBRICATED CUTTER AT WORK.

The Newton Machine Tool Works, makers of the cutter and milling machine herein illustrated, propose to adapt all new milling machines built by them for using cutters of this type.

I noticed quite a little kink for filling oil-cans in these shops. It is a common kerosene oil can with trunions and mounted on uprights which are fastened to a wooden base block. The whole affair is placed in one end of an ordinary dripping-pan and stood on a bracket projecting from one of the shop posts. As shown in the photograph on page 22, the oil-can to be filled is placed in one end of the dripping-pan and the large can is tipped over until the oil flows from the spout into the small oil-can. If any oil should be spilled during the operation or the small oil-can filled to overflowing, the waste oil is caught in the dripping-pan, from which it can be emptied and returned to its proper receptacle. The whole thing struck me as being exceedingly cheap and economical.



DIFFERENT METHODS OF KEYING.

In the *American Machinist* of April 23, Mr. Chas. T. Porter describes a method used by him of boring fly-wheels and pulleys it consists of boring the wheel or pulley the size of a forcing fit for the shaft, and then shifting it on the boring mill about $\frac{1}{16}$ inch and boring out a thin crescent on one side and extending a little over half of the bore. This allows the wheel or pulley to be easily slipped on the shaft, and when keyed up tightly is brought to a bearing nearly half way round the shaft and the face will run perfectly true. The construction is shown by Fig. 1.

This suggests a modification in the boring of the ordinary pulley of commerce, where the shaft is generally under size and the hole in pulley a little large. The trouble in this case is that the pulley practically bears on the shaft on one side of the hole and the set screws or key on the other side, a combination which is always getting loose. If the hole in pulley is made about the same shape as the hole in a lathe dog, as shown in Fig. 2, the bearing will be on three points, and when the pulley is once properly tightened it will stay tight.

I used to be troubled with finger bars on the shipper-rods of counter-shafts coming loose, and have known some that had to be tightened so frequently that the set screw had almost "chewed" the shipper-rod in two. Finally I made a pattern for a finger-rod with a core print and box like Fig. 2, and had some castings made. They were put in service and I never knew of one that had to be tightened up afterwards.

As many will object to Fig. 2 as being an expensive shaped hole to machine, I would suggest one like Fig. 3. This, like Mr. Porter's method, consists in boring the pulley to a fit for shaft and shifting it twice on the boring mill, instead of once, at one shift, boring out a crescent considerably more than half way round on one side of the hole, and at the second shift boring out a crescent somewhat less than a third the way round on the opposite side of the hole.

In either case the pulley is turned on an arbor the same size as shaft it is to fit, and is held on the arbor just as it is to be finally held to its shaft. Thus it will run true on its shaft, can be put on or taken off without trouble, and when once tightened up it will stay tight.

* * *

PROPORTION OF GEAR TEETH.

SAMUEL WEBBER.

I notice a new aspirant for honors on the subject of "Proportions of Gears," in the June number, "H. Heyrodt," and as I think him entirely wrong in proposing the *tensile* strength of cast iron as his basis, instead of the *shearing* strength, I wish to call attention again to some of the data collected by my old friend, John H. Cooper, to which I referred in my article in this paper in March, 1895. Mr. Heyrodt adopts a very curious formula: he takes the tensile strength of cast iron at 18 600 pounds, and allowing a factor of safety of 8, he makes the *safe* strain on a square inch 2 312 pounds. He then doubles this up with another factor of safety, quoting from Weisbach, from which he deduces the safe strain, which thus amounts to one forty-eighth of the tensile strength. Now the strain on a gear tooth is not tensile, it is that of "can tilever," or a beam loaded at one end, and I quote from Mr. Cooper what he quoted from Boulton and Watt, as follows:

"A bar of cast iron 1 inch square and 12 inches long bears 600 pounds before it breaks; 1 inch long will bear 7 200 pounds, and $\frac{1}{15}$ of this = 480 pounds, is the load which should be put upon a wheel."

Mr. Cooper then quotes Mr. Campin, as saying in the *Artizan*, that the breaking load of such a bar is 8 000 pounds, and says "we can therefore rely upon Boulton and Watt's data, *i. e.*, 7 200 pounds breaks a bar of cast iron 1 inch square by 1 inch long, $\frac{7200}{8}$=2 400 pounds, the elastic limit, which if exceeded would end in rupture, and $\frac{2400}{5}$=480 pounds, the safe load."

Now, the United States Ordnance Department tests of American cast iron gave a breaking strain of 7 969 pounds per square inch. Mr. Thomas B. West's tests, as published in the *American Machinist*, showed over 8 000 pounds, and I have adopted that

as my standard, using a factor of safety of 16, and calling the safe load 500 pounds per square inch, instead of 480 pounds. As it is impossible for me to quote all the valuable data contained in Mr. Cooper's paper, I will ask such of my readers as can, to refer to the original paper, in the *Journal of the Franklin Institute*, for July, 1879. I shall, however, quote somewhat at length from Mr. James Christie, the well known engineer of the Pencoyd Iron Works, as his remarks bear pertinently on my recent amicable discussion with Mr. Klindworth. Mr. Christie says:

"I have collected a number of cases, varying from 1 inch pitch up to 4 inch pitch, where the teeth are strained up to their utmost safe endurance, and feel convinced that the teeth of wheels can be treated in a rational way, as a beam rigidly supported at one end and loaded at the other; that is, loaded at the pitch line, and all the load on one tooth.

"Further, assuming that the length of beam or tooth is taken at four-tenths of the pitch, a usual proportion of distance from the root of the tooth to the pitch line, and also taking the "*modulus of rupture*" at 36 000, would give for the teeth of cast iron wheels a breaking strain of 3 700 pounds for each inch of pitch and face, and advancing directly as the pitch and the face, although the transverse strength of rectangular sections increases as the square of the depth, yet in the case of the teeth of wheels there is an inverse decrement, owing to the proportional increase of length of tooth.

"My rule would therefore be for cast iron teeth, *Pitch* × *face* × *3 700* = the ultimate breaking load in pounds. On account of the imperfect elasticity of cast iron, the working load should never exceed one-quarter of the breaking strain and then under the most favorable conditions, such as well fitted gears, rigidly supported, running at moderate speed and stress evenly distributed. For strains suddenly applied, the factor of safety should be 6, and when accompanied by severe shocks and sudden reversions, it should be 8.

"These are my opinions, and I am prepared to sustain them by numerous examples, a few of which are given herewith: Spur-wheels of $1\frac{1}{16}$ inch pitch and 4 inch face, on a crane, which for years have been subjected to a tooth strain of 500 pounds per inch of face, one of 4 inch pitch, and one of 12 inch face, every day working under a strain of 25 000 pounds, and often 30 000, suddenly applied on the teeth; another of $2\frac{1}{4}$ inch and 8 inch face, subject to a frequent stress of 10 000 pounds, but which has had two breakages when the strain amounted to 13 500 pounds suddenly applied, or 1 700 pounds (nearly) per inch of face.

"In estimating the moment of resistance, I use the *modulus* suggested by Rankine, viz., 18 times the weight applied at the center necessary to break a bar 1 inch square, and 1 inch between supports. In ordinary foundry iron this may be accepted as averaging 36 000 pounds, as stated, but as there is a wide range in the strength of cast iron, or another material may be applied, a sample experiment will determine the proper *modulus*, and according as the result obtained will exceed or fall below 36 000, so will the proper coefficient in the formula vary from 3 700. Many of the old English rules for strength of teeth are based on the presumption that the teeth do not in action bear over the entire length of face, but only on the corners, in which case the line of rupture is a diagonal, rendering any increase of face of tooth beyond double its length needless."

I have thus quoted Mr. Christie pretty fully, from Mr. Cooper's paper, believing him to be quite sound authority, and it now remains to say that his rule of "*Pitch* × *face* × *3 700*" is almost the same as mine of "*Thickness* × *face* × *8 000*," for the ultimate breaking strain, as mine would be "*Pitch* × *face* × *3 680*," if the thickness was as usual assumed to be 0.46 pitch. This brings me back to my starting point, that a pressure of 500 pounds per square inch gives a factor of safety of 16 at the pitch line, or really as far beyond it from the center as 0.46 is to 0.40. If the length of the tooth is as usually assumed, 0.70 of the pitch, the factor of safety at the point is 10.5; if it is 0.60, the factor is 12.27. Now, one of Mr. Christie's examples quoted shows that a tooth of $2\frac{1}{4}$ inch pitch, or 1.035 inch thickness, only broke with a suddenly applied strain of 1 700 pounds per inch, while it stood safely a frequent strain of 10 000 pounds, or nearly 1 250 pounds per inch, so 500 seems to be safe. From this we get the formula

$$S = \frac{500\, f\, t^2}{l}$$

and if f is 2.5 P it will be 5.5 T, and as 1 HP. is equal to 550 pounds moved 1 foot per second, we may obtain the following:

$$\text{HP.} = \frac{500 \times 5.50 t^3 \times v}{l \times 550}$$

Divide by 550 to eliminate and we have

$$\text{HP.} = \frac{5 \times t^3 \times v}{l}$$

Now, as I am working for the strength at the pitch line, we assume l to be only equal to T, and dividing by it gives HP. = $5\, t^2 \times v$, it being understood that v is velocity in feet per second.

If the velocity in feet per minute is taken it would read

$$\text{HP.} = \frac{v - t^2}{12}$$

This, as just stated, is load at the pitch line or rather just beyond it, at a distance from the base equal to the thickness of the tooth, with a factor of safety of 16 to 1 at that distance, and one of from 10.5 to 12.27, according to length at the point of the tooth, and this is supposing only one tooth to be in contact. I think the quotation from Mr. Christie shows this to be safe, unless a very heavy load is suddenly thrown on.

Mr. Cooper, in his paper, supposes a gear as follows: Diameter 5 feet, pitch 3 inches, thickness 1.38 inch, length 2.10 inches, face 6.5 inches, R. P. M. or n 60, velocity 15.708 feet per second, t=.46 P, l=.7−p, and quotes a long list of formulæ which he works out, showing the power given by each one for this gear, viz.:

		HP.
Boulton and Watt	$H = \frac{p^2 \times f \times d \times n}{306}$	= 66.17
Tredgold	$H = \frac{p^2 \times v}{1.75}$	= 80.78
Fairbairn	$H = \frac{t^2 \times v}{.344}$	= 86.96
Haswell	$H = v \times t^2 \times 5.45$	= 163.
Jones and Laughlin	$H = \frac{p \times d^4 \times f \times n}{550}$	= 147.27
Nystrom, for two teeth	$H = \frac{t \times f \times v}{.55}$	= 295.29
My own gives	$H = t^2 \times 5v$	= 149.57

and as it agrees so closely with that of Messrs. Jones and Laughlin, who are right in the thick of the iron business at Pittsburg, I am contented to stand by it, more particularly as it has received the approval of such a safe engineer as the late James B. Francis. To return to Mr. Heyrodt, I will not criticise his deduction of 2.51 HP. from a gear mentioned by me in a former letter, instead of 251 HP., as the decimal point may have been misplaced by that ingenious and immortal scourge of the printer, the "devil," but will say that my rule gives for his own gear 13.747 HP., instead of 7.89 HP., as he makes it. Mr. Klindworth's advocacy of width, to save wear, is all right in some cases, but most engineers recommend a width of not over 2.5 P.

Strictly speaking, Mr. Haswell's formula is more logically correct than mine, as it is based on the length of tooth to the pitch, = four-tenths of the pitch, while mine is based on a length equal to the thickness, .4545, or five-eleventhsths of the pitch. This gives him 5.45 $v\, t^2$, with 0.40 length, and the difference in thickness at those distances would be inappreciable. In either case, the strength is re-enforced, by the amount of swell at the base of the tooth, which widens it beyond the pitch line thickness.

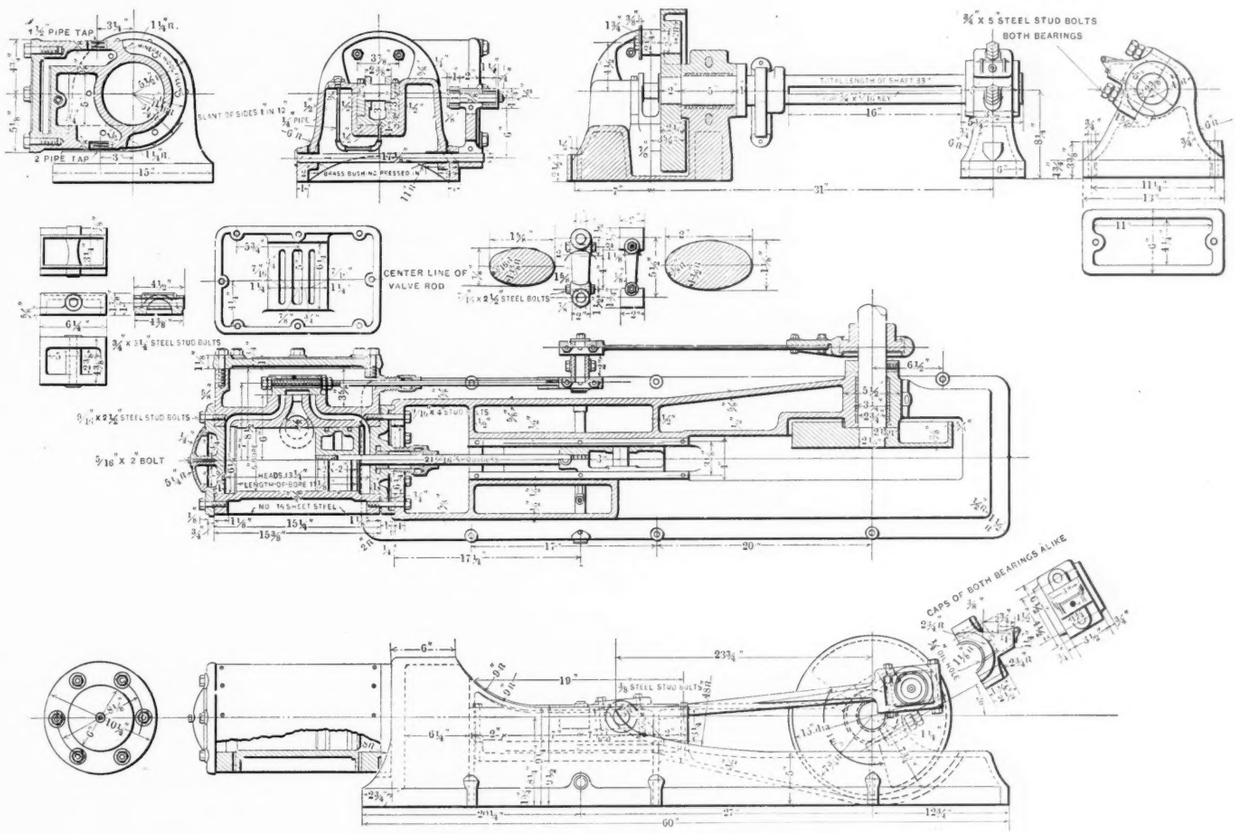
OBITUARY.

JOHN J. HOGAN, whose article on Boiler Reform, in our January issue, attracted considerable attention, died at his residence at Middletown, N. Y., on July 30th, of Bright's disease. He was born in Ireland, was educated in Dublin and Belgium and served an apprenticeship at the Reading Iron Works, a fee of about $1,500 being paid for this apprenticeship. He resided in both New York and St. Louis, but since his invention of the Hogan boiler and the establishment of the boiler works at Middletown, N. Y., he had made that city his headquarters.

READY MADE ENGINE DRAWINGS.

These are the work of Otto E. Evans, of York, Nebraska, and the ones shown give the main drawings of a 6 x 9 inch slide valve engine, which should be interesting to machinists and apprentices as well as engineers. There is quite a demand for this class of engine in some localities, and it is manifestly cheaper and better to buy drawings already made, by one who has had experience in that line, than to attempt to build engines without good plans and correct dimensions. The price of these blue prints is very low, and as they can be obtained in four sizes, it will pay those who intend going into this business to communicate with Mr. Evans. A good general idea of an engine of this size and style may be obtained by carefully noting the details and general dimensions, and should prove instructive to anyone who cares to give it the necessary time and attention.

* * *



DRAWINGS OF A 6X9 SLIDE VALVE ENGINE.

STRENGTH OF GEAR TEETH.

CHAS L. GRIFFIN.

When the attempt to deduce a general formula for the strength of gear teeth is made, a difficult problem is undertaken. It seems, however, to be capable of many and varied solutions. Mr. John H. Cooper's researches tell us that about fifty different rules exist for computing the strength of gear teeth, and that the extreme cases differ from each other by about 500 per cent! This is somewhat encouraging to the novice, in that, if he falls within these limits in his investigations he is at least just as correct as the other fellows. Prof. Harkness's expert researches appear to have been quite exhaustive, while those of Mr. Wilfred Lewis have not only been equally so, but have been put into perhaps the most available shape for practical use of any that have appeared. It is noticeable, however, that Mr. Wm. Kent in his recent publication, "Mechanical Engineers Pocket Book," after carefully reviewing the work of all these writers, makes this statement: "For rough ordinary work the old English rule $W = 200\, p\, f$ is probably as good as any, except that the figure 200 may be too high for weak forms of teeth and for high speeds." (W = load in pounds at pitch line, p = circular pitch in inches, f = face of gear in inches)

This may be interpreted in verbal language as meaning that the load which any gear will carry is always positively dependent upon the pitch and face, which is manifestly correct. The result so obtained, however, must be multiplied by a factor which shall influence the final conclusion according to the conditions of the case. This factor considers the material used, the shape of the tooth, the number of teeth in action at one time, the velocity, the shock, whether light, moderate or heavy, and a so-called "factor of safety" introduced to cover what the engineer deems uncertain conditions. It is this factor which all writers are quibbling over and, considering the variable quantities which enter into it, it is not a matter of surprise. Indeed, the personal element of the engineer comes in strongly on the introduction of the "factor of safety," and it is a question whether, after all, this is not the decisive one. With all due respect to the refinement of theory, practice does not require too literal an application of it in the case of gear teeth. The engineer must decide how closely the assumptions are realized in any given case, and it is entirely possible to design gearing with safety by carefully judging the size of the general factor without building it up piece by piece and then throwing in something for luck at the end. In fact the former seems the more scientific method of the two. Mr. Kent's statement concerning the English rule would indicate that the gear is more a result of engineering judgment than that of absolute adherence to either theoretical or thumb rules. It has been the writer's practice to base designs upon figures varying somewhat from the 200 factor of the English rule. The figure 250 has been found a good average for cast teeth not shrouded, and 350 for cut teeth, the material being a high grade of cast iron. For steel, factors of from two to two and one-half times the above are good standards.

However strongly the above may appeal to readers, the advantage of designing by the use of a factor of strength is evident, and it is for the convenient use of this method that the accompanying diagram is offered. It simply represents the relation between four quantities, viz. load, pitch, face and factor of strength, and makes no attempt to solve the problem of design, until the factor suitable for the given case is arrived at. This may be found according to the preference of the user. Careful judgment will give good results, or if it is preferred to use Mr. Lewis's data, the factor "K" as used in the diagram is equal to the Lewis "factor

for strength" multiplied by the Lewis "safe working stress." These data are found in convenient form in Kent's Pocket Book. The value of the diagram lies in the readiness with which the effect of varying any one of the four quantities may be seen. The writer has used the diagram on a most varied class of power work, and has found it of particular value in determining at once the relative degree of loading thrown upon the members of a given team of gears. In designing standard machinery, it affords a quick method of proportioning so as to work every gear in similar location just as hard as every other gear. The factor "K" is always a measure of the intensity of work, and after a little practice with the diagram the standard figures for particular locations or conditions of use become as familiar as the allowable stress in the structural members of a machine.

It will be noted that the diagram covers both circular and diametral pitches. The term "standard face" is used in an arbitrary sense, some width being necessary as a base. The widths have secured a factor of 330 by using a 2¼ pitch gear with a face $4.2 \times 1\frac{1}{8} = 4.9$ inches. Other combinations are as easily read.

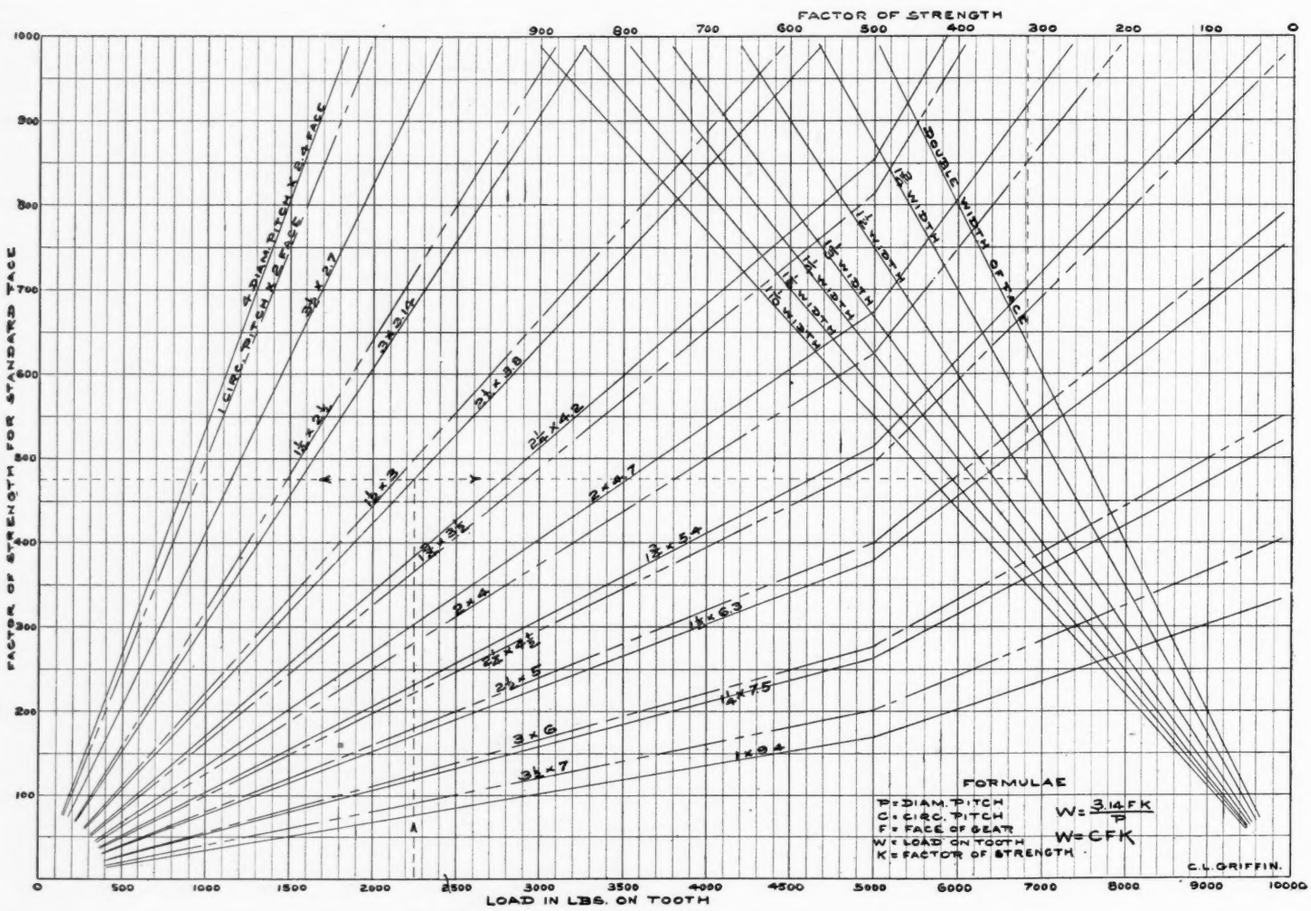
* * *

PRACTICAL TALKS ON MECHANICAL DRAWING.—10.

Louis Rouillion.

PATENT OFFICE DRAWINGS.

The applicant for a patent is required by law to furnish a drawing of his invention whenever the nature of the case admits of it. This drawing differs from a working drawing in that it has for its object the illustration of principles rather than details of construction. The rules of practice at the patent office contain exact instructions regarding the nature of the drawings to accompany all applications for patents. These instructions must be complied with or the drawings will be rejected.



STRENGTH OF GEAR TEETH.

of face as chosen depends on the circular pitch, and are taken at twice the circular pitch where circular pitches are read (dot and dash lines), and three times the corresponding circular pitch where diametral pitches are read. This is in deference to the usual custom of defining cast gears by circular and cut gears by diametral pitch. It was considered likely that a cut gear would ordinarily take full bearing on the teeth with 50 per cent. greater face than a gear with cast teeth.

The diagram reads from four diametral pitch to one diametral pitch, which is the range of work subject to ordinary conditions. It reads from standard face up to double face. Double face could be used on a cut gear provided alignment be good and journal support rigid.

An example is noted on the diagram by a dotted line which illustrates its use. A load of 2 250 pounds on a 2½ diametral pitch gear of standard face 3.8 inches will work the teeth to a factor of 475. By increasing the face 50 per cent. we shall reduce the factor to about 320 as indicated. Practically the same result could have been attained by changing the pitch to 2 with 4.7 inches face when the factor would have been 300, or we could

1. PAPER.

To be pure white, calendered, of a thickness corresponding to three-sheet Bristol-board.

2. SIZE OF SHEET.

To be exactly 10x15 inches. One inch from its edge a single marginal line is to be drawn, leaving the "sight" precisely 8x13 inches. Within this margin all work and signatures must be included.

One of the shorter sides is regarded as the top, and, measuring downwards from the marginal line, a space not less than 1¼ inches is to be left blank for the heading of title, name, number and date. These latter to be filled in at the patent office, to insure uniformity.

3. SCALE.

Should be large enough to show the mechanism without crowding, and two or more sheets should be used if one does not give sufficient room to accomplish this end.

4. METHOD OF DRAWING.

Orthographic projection is generally used, but frequent use,

however, is made in isometric drawing. True perspective is sometimes resorted to, but the results obtained by the first two methods are preferable.

5. INKING.

All drawings must be made with the pen only.

India ink alone must be used.

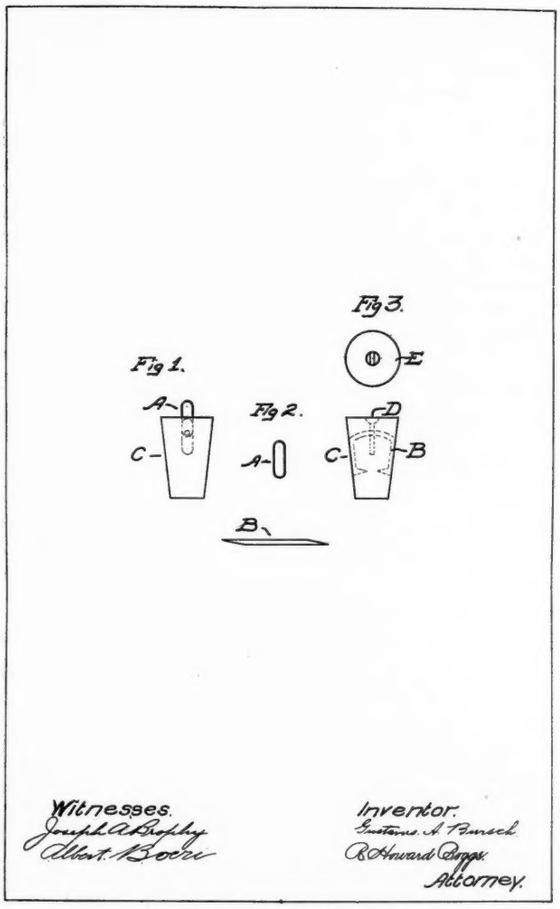
Every line and letter (signature included) must be absolutely black.

6. SHADING.

Drawings should be made with the fewest lines possible, consistent with clearness, and little or no shading should be used.

Heavy lines on the shade side of objects should be used.

The light is always supposed to come from the upper left-hand corner of the sheet at an angle of 45°.



7. LETTERS OF REFERENCE.

The different views should be consecutively numbered, *e. g.* Fig. 1, Fig. 2, etc.

One-quarter of an inch is a good height for this lettering.

Use letters of at least one-eighth of an inch in height for designating different parts.

If the same part appears in more than one view of the drawing it must always be represented by the same letter, and the same letter must never be used to designate different parts.

8. SIGNATURES.

The signature of the inventor should be placed at the lower right-hand corner of the sheet beneath the word "Inventor," and the signatures of the two witnesses at the lower left-hand corner beneath the word "Witnesses," all within the marginal line.

9. MISCELLANEOUS.

When the invention consists of an improvement on an old machine, the drawing must exhibit the invention itself disconnected from the old structure, and also, in another view, so much only of the old structure as will suffice to show the connection of the invention therewith.

The title should be written in pencil on the back of the sheet.

Drawings should be rolled for transmission to the patent office, not folded.

The instructions for making patent office drawings are put in the above concise form for ready reference. Specimen drawings, illustrative of prevalent practice, are shown in Figs. 44–48.

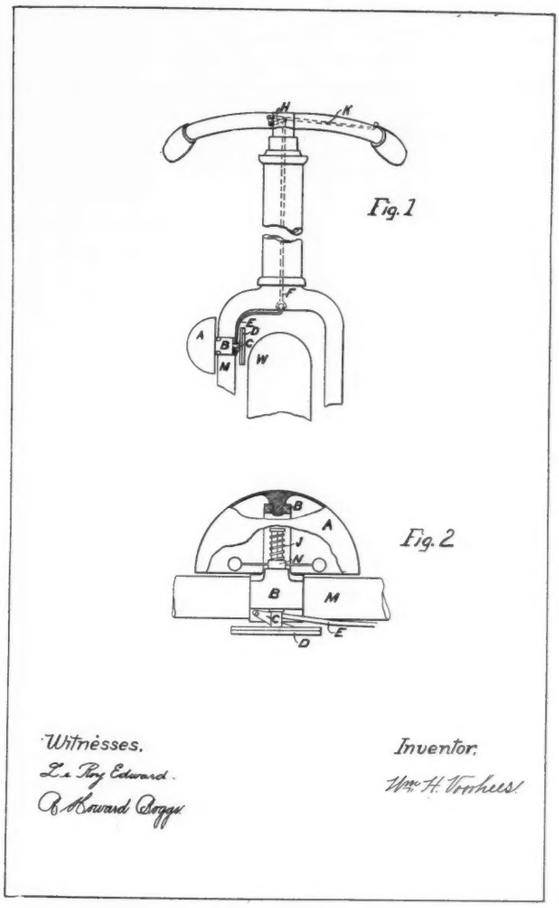
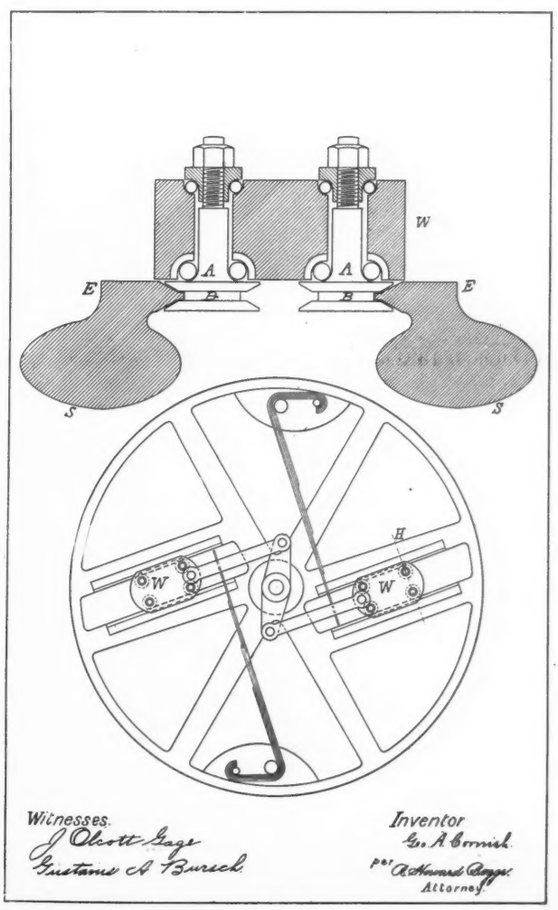


Fig. 44 represents a bottle-stopper with an extracting attach-



ment. The letters and figures are of a fair size. The same letters indicate the same parts in the various views. The inventor's name is placed at the lower right-hand corner. If an attorney is engaged to conduct the application for a patent, his name follows that of the inventor. The signature of the two witnesses are placed at the lower left-hand corner of the sheet.

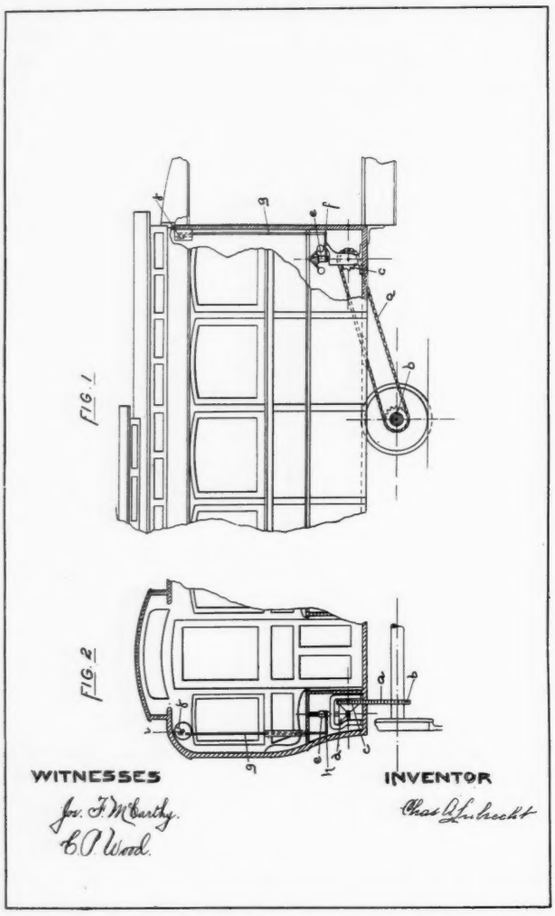


Fig. 45 shows an improvement in bicycle bells. The upper drawing represents the method of attaching the bell to the bicycle. The lower drawing is made upon an enlarged scale and gives the details of the mechanism.

The letters in this and the other drawings are letters made use of in the written specifications for referring to the various parts of the drawing.

Fig. 46 also makes use of two scales upon the same drawing. The lower drawing gives a general view of the special form of inertia governor that constitutes the improvement or invention, and the upper drawing gives an enlarged view of a detail.

Fig. 47 is one of a series of drawings accompanying an application for a patent on an improvement in street-car speed indicators. This particular drawing illustrates the actuating mechanism.

Fig. 48 shows, in the upper part, a drawing in isometric projection. This drawing serves to show more clearly the use of the apparatus shown in detail at the lower part of the sheet.

A pamphlet, "Rules of Practice," issued by the Commissioner of Patents, and containing full information regarding patent office practice, may be obtained, free of charge, by addressing "Commissioner of Patents, Washington, D. C."

* * *

FRICTION COUNTERSHAFTS.

T. E. F.

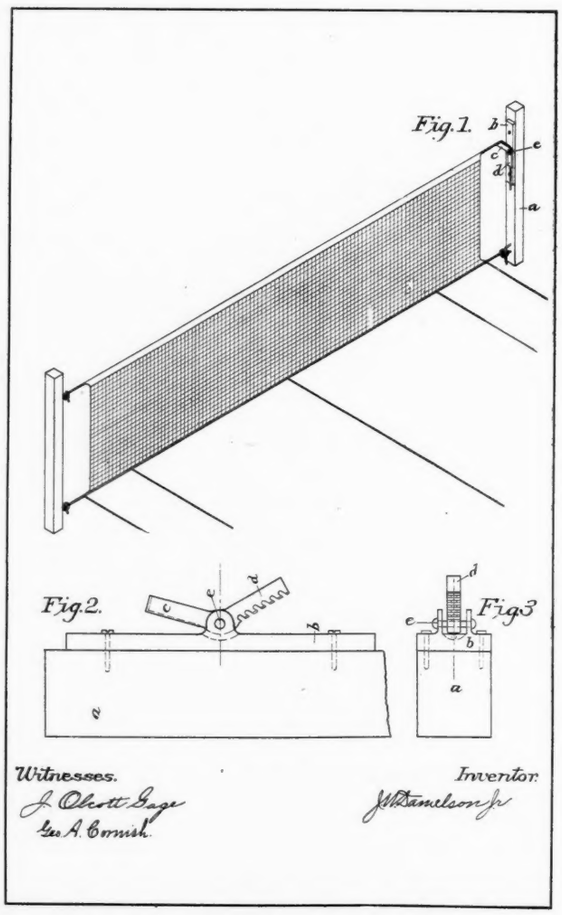
I would like to say a word about some countershafts which are causing me lots of trouble. The ceilings are rather low and belts to the machines have to be kept taut. Every maker of lathes, millers, monitors, cutting-off machines, etc., has a friction clutch of his own "get up;" some catch in center around a hub or cone, others inside the rim, some on the spokes, others on a continuous rim on the spokes, while some will clamp for good, "never to let go again." The greatest trouble with them all is that the friction surfaces cannot be kept free from oil and excessive pressure must be applied to get them to pull. The oil holes, for oiling the continuous running parts, are never worked out properly, so that the oil never gets where it should go. The best way I find is to take the pulleys which give trouble and put a metaline bushing in them. They last quite awhile and can be changed without much trouble.

On countershafts there are generally two friction pulleys, one for reverse or fast speed. I often notice the fast running pulley in the center of shaft. That is manifestly wrong, as that pulley should be close to the hanger to reduce possible vibration to the shafts, which are generally lighter than they should be. Turning down countershafting on ends for the bearings should be done away with, as that requires too much fitting in putting up; stop-collars are much handier.

The hangers should be self-aligning and self-oiling, the drop should be about one inch more than the radius of largest pulley, as on a low ceiling every inch counts. This question of drop of hanger is a point I particularly wish to call manufacturers attention to.

Make width of belt of generous proportion, as there is no fun lacing belts high up in the air and putting them on, especially if you have continuous drivers as some shops have, which are very foolish to say the least. The legs of the hangers are not usually as strong as they should be, and I have had several of them coming down. One broke when starting up too fast, one broke when reversing a lathe, one countershaft got pulled down by the driving belt getting tangled up with its neighbor on a continuous drum, and just six inches saved the writer from a sure death.

The shifter should be so placed so as to be handy for the operator and out of the way for all travelers. Have distance between pivot and fulcrum as long as possible, as that will make it easy for the operator. Make it wide across the fulcrum, as it will break there first.



If the machinist or operator is a civilized man and wears a white shirt and collar, don't disturb his equilibrium or temper by oil drops from the counter-hangers landing on his collar, neck or face, but have drip-cups of generous proportions placed under hangers and keep them empty or next to it. Be sure your counter is beveled and parallel with main shaft.

TWO AND TWO MAKE FOUR.

CLAIMS AND THEORIES.	FACTS AND EXPERIENCE.
	cents, is accepted for one hundred cents only because the Government in effect declares it to be good for that amount; and because the amount of such coins put out under the stamp or the guarantee of the Government is *limited*, so that the business community believes in the Government's ability to make good its guarantee. When this ability is doubted because of the amount for which the Governernment is responsible, the same principle which is applied to the credit of a smaller country will be applied to this, and these silver coins will fall to a value represented by what the silver in them will sell for—just the same as the money of Mexico or any other silver country sells for.
	In the Argentine Republic gold payments were suspended in 1885, and at that time the average wages of a skilled workman were $40 a month. To-day the average is $60 a month in paper, but his paper dollar will buy only about one-third what his gold dollar did, on account of the general advance in all commodities.
	An extreme example of the difference between the *face* value and the *real* value of money may be found in the purchasing power of confederate money in the South during the war. When this was first issued, its purchasing power was considerable, because for some time it appeared that the South would succeed and would be able to redeem the notes. Later, it required $300 to $500 to buy a pair of shoes, $2,000 to $3,000 for a suit of clothes, etc. In other words. the accepted value of the money fluctuated according to the faith of its holders in the ability of the Government to make good its guarantee.
That free coinage will cause silver to rise in value to the equivalent of gold (at sixteen to one), because we would absorb all the silver in the world and practically create a corner in that metal.	To accomplish this we would be obliged to raise the price of all the silver in the world to $1.29 an ounce, *and hold it there*. This can be accomplished only by constant purchases when the price falls to that figure. The silver *money* in the free silver countries amounts to about $2,000,000,000; this does not include silver in other forms. The world's annual silver bullion product must also be taken care of. This amounts to $200,000,000 or so.
	During the Bland-Allison Act, when the Government was buying $2,000,000 monthly, and during the three years of the Sherman Silver Purchase Act, when the Government was buying 54,000,000 ounces annually, silver steadily decreased in value from $1.16 to $0.73.
	In India, the greatest silver consuming country in the world, with a population of about 300,000,000, the rupee fell under free coinage from the value of 2 shillings (50 cents) to a little more than 1 shilling. In 1893 the Indian mints were closed to free coinage and the rupee immediately began to rise, having now a value of about 14d. (28 cents.)
	In Mexico the silver dollar has fallen in value from $1.32 in 1870 to about 54 cents in 1896.
That the sound money men are engaged in a general warfare against silver, for the purpose of lowering its value and preventing its use as a money metal.	This is in no sense true. There is no objection on the part of sound money men or anyone else, to the use of silver as money, provided the amount is *limited* to the actual requirements of trade; for in this case the silver in circulation could be maintained on a parity with gold, without becoming a burden to the country as it has been of late years. The extent of this burden may be measured by the statistics of the Treasury, where 379,852,244 silver dollars lie idle. *Less than one seventh* of the entire number coined are in actual circulation.
That the population of the world is constantly increasing, while the supply of gold is growing smaller in proportion. This is given as a reason why gold should not be used as a basis of value.	The world's gold production has steadily increased for at least twenty years in greater proportion than the population. The production since 1878 is given below: In 1878..... $96,200,000 1880..... 106,436,800 1890..... 118,849,000 1894..... 180,626,100 1895..... 203,000,000 1896 (Mint estimate)..... 220,000,000 The total production between 1873 and 1894 was $2,526,834,000.

All the facts here presented, and many others we omit for lack of space, show that in this country under the gold standard, during the last twenty years and more, wages have steadily increased and the prices of nearly all staple articles have steadily decreased; while in silver countries almost the exact contrary is the case.

It must be evident to every one who has honestly studied the foregoing statistics, that the present conditions are *not* the result of a lack of money for circulation purposes; but due to three causes—over production, tariff agitation, and legislation which menaced the standard of value. The last cause is the most powerful disturbing factor of all, and until it is finally removed, prosperity will not return to the country.

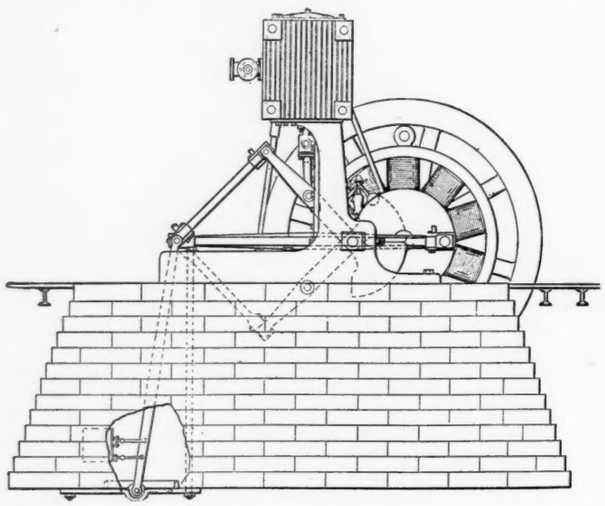
But let us suppose that free coinage had become a law and that any one having fifty-three cents' worth of silver in his possession could take it to the mint and get a silver dollar for it. How is this going to benefit you, plain Jack Robinson? It may benefit the mine owners and capitalists who are able to accumulate silver, but how are the wage earners to profit by it? Suppose prices of food and clothing are to be doubled on the first of next January, will you undertake to say that you can go to your employer and obtain from him double your present pay? Don't you know that a revolution of this character, whatever its after effects may be, will disorganize values and unsettle business for years to come? Don't you know that when business is unsettled, when men are afraid to undertake new enterprises, when manufacturers hesitate to put in new machinery or appliances, when no one buys except what he absolutely requires—don't you know that the workingman suffers more than anybody? Don't you know that the demand for the product of his labor falls off, and that his employer *cannot* advance his pay because he hasn't work for him at even the old wages?

Reason this thing out yourself. Apply the same common sense rules to it that you do to the ordinary questions of your daily life. Don't run any unnecessary risks with the bread and butter of your wife and children. Don't jump over a precipice in the dark. Don't take the theories or metaphors of politicians for facts. Don't accept the opinions of any man as your *belief* until you can find a reason for them that appeals to your common sense, and satisfies it as surely as you are satisfied that two and two make four. L.

ITEMS OF MECHANICAL INTEREST.

A METHOD OF DIRECT CONNECTION.

In a paper recently read before the Engineer's Club, of Cleveland, O., Mr. E. A. Sperry, well known in electrical circles, proposed the accompanying design for a direct (or we might say very indirect) coupled Corliss engine and dynamo. The object is to use a slow running engine and yet run the dynamo faster, at double the engine speed in this case, so as to reduce the first cost



of the dynamo. A little study will show its method of working and also disclose the fact there are at least five additional bearings, and with double rods, as the writer suggests in some cases, this number will be increased.

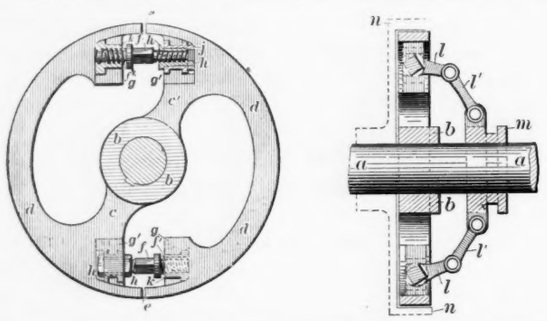
Prophecy is dangerous, but if the writer was called upon to solve such a problem, he would prefer gearing, using the helical tooth for steadiness and continuous pull, to any such arrangement as shown. Numerous parts and bearings are good things to avoid.

OSCILLATING ENGINES.

The oscillating engines of the Sound steamer *Connecticut* have broken down so effectually that they will probably have to be replaced by another type of engine. The high pressure cylinder is 56½ inches in diameter, the low 104 inches, and both have a stroke of 11 feet. Both cylinders have two piston rods; the high 9 inches, the low 10 inches in diameter. When the immense weight of these cylinders is considered, it is little wonder there has been continual trouble with the trunnions heating, and this was not aided by the passage of steam into and out of the cylinders through these trunnions. It is probably safe to say that there will be no more of this type of engine built on such a large scale, and it affords an example of the unmechanical practice of continually reversing motion in such a mass of metal.

A FRICTION CLUTCH.

The question of friction clutches is always interesting, and the one shown herewith is somewhat different from those usually employed in this country. This is credited to a Mr. Heywood and as being made by Richard Rankin, of Liverpool, England. It is



very similar in idea to the one made by A. Edmeston & Sons, Cannon Street Ironworks, Salford, England, the difference being that the latter company usually employ but one right and left screw instead of two as in the Heywood clutch. There is little that needs explanation, the movement of the spool *m* by the clutch rod or shipper, turning the right and left hand screws through the links *l* and *l'* and forcing the clutch ring open by a positive motion.

A NEW AIR COMPRESSOR.

This is one of the mechanical monstrosities of the day, being another of the many cases where power is supposed to be created. It consists of a huge horizontal wheel, 82 feet in diameter, built up from structural steel and having ten spokes. At the outer end of each spoke is a set of three solid wheels 9 feet in diameter, which weigh over 4 tons each. The central wheels run on a circular track and support the frame work, while the two other wheels operate a series of compound air pumps placed around the track inside and outside, by rolling upon and moving levers connected to the air pumps. The pump cylinders are 12 and 16 inches in diameter, have a stroke of 12 inches, and there are 100 of them distributed around the track of this huge "merry-go-round." The wheel is driven from the center by two compound engines of about 70 horse power each, although they are practically independent of each other. It is intended to compress air to 100 pounds pressure per square inch and distribute it through mains for power purposes, the machine being calculated to develop 2 500 horse power.

When it is considered that the wheel is driven by only 140 horse power this is surely a modest claim, and when an air compressor can develop nearly 18 times as much power as is put into it, it may certainly be called reasonably efficient. This is the design of E. Chaquette, Bridgeport, Conn., who is probably just as confident that it will do what it claims as we are that it will not.

A WATER TUBE BOILER.

Another "grandest discovery of the age" has come to light in the shape of the Green Water Tube Boiler. This can only be used with oil or gas fuel, the flame being blown into a drum containing from 300 to 400 tubes which are open at each end and through which the water circulates. The drum, which is really the firebox, is also surrounded by water, and a pipe, forming the outlet for the gases, runs from the top of the drum up through the water and steam space.

It is claimed to have such rapid circulation of water that the tubes will be made *bright* from the friction of the water; the effect of muddy or gritty water on the tubes, circulated at this rate, is not mentioned. A boiler 22 inches in diameter by 52 inches high is rated at 25 horse power. It also claims something in the way of rapid steaming, as 100 pounds pressure can be raised in five minutes; and as an ordinary boiler requires an hour, this gives it an efficiency of 12 to 1, at least so the circulars say. It is the invention of J. E. Green, 1606 North 14th St., St. Louis, Mo.

* * *

LONG FEED MILLING MACHINES.

These machines form a complete series, built by the Brainard Milling Machine Co., Hyde Park, Mass., including fifty, seventy-two, eighty-four, ninety-six, one hundred and eight and one hundred and thirty-two inch, especially adapted for key seating shafting, but equally applicable to any plain milling. We show the eighty-four inch machine, which, though weighing 8,000 pounds, is very convenient and easily handled. The table sets low, is actuated by a bronze worm running in oil, driven by a hardened steel worm and wheel at the end of bed. A dial, graduated to thousandths and sixty-fourths of an inch, is connected with the elevating screw and also with the cross screw.

The carrier, upon which is mounted the driving spindle, is gibbed to the head, and has a vertical range sufficient to allow work eighteen inches high to pass under centers. From this carrier projects a large arm for outside support of mill spindle, intended for use on work where a back stand is not admissible. There is, however, as may be seen, a back stand or tailstock of very solid character. The arm is readily removable when desired, and the tailstock can be slid off its seat if required, making it an open side machine. In most cases, however, the arm need not be removed, its yoke being swung up out of the way, leaving the center of mill arbor free to engage with that on the back stand. This combination provides for operation on a wide range of work.

As shown in the engraving, the space between head and tailstock is about twenty-four inches, but if required, the tailstock can be made to travel in line with the head, and its support be extended to any distance desired.

The method of driving the spindle allows of its free adjustment

without disarrangement of the driving and feed belts. The driving cone has three steps for 3½-inch belt, or two steps for a 5-inch belt.

The machine as shown has longitudinal feed only, but where it is desired, an automatic feed motion can be applied to the elevating screw in the head, giving feed in a vertical direction.

The table is arranged to run backward and forward rapidly by power, by a device which is not seen in the engraving. As the table weighs a ton the relief to the operator by this improvement is obvious.

All the operations of the machine are intended to be conducted from the front side, without change of place by the operator. The feed can be thrown in or out by hand at any point by means of a rod which connects with the latch, shown at the front of the cut, or is dropped automatically by an adjustable dog. While the work table is intended to run back by power, it can also be operated by hand, in either direction, by means of a large hand-wheel.

The machine is massive in all its parts, and is intended for heavy milling of any description, but more particularly for shafting, railroad or engineering shops, being specially adapted for key seating long and heavy shafting, finishing guide-bars, connecting-rods, etc.

Weight	8 000 lbs.
Work table is 7 feet long by 20 inches wide.	
Longitudinal automatic feed	84 inches.
Cross adjustment of head in line with spindle	2 "
Elevation of centers above work table	19 "
Distance between heads	24 "
Spindle solid steel, 4 inches diam. in front bearing.	
Diameter driving wheel	32 "
Mill arbor 2½ inches diam., fitted 10 inches deep in spindle.	
Arm center support 5 inches diam. at smallest part.	

This machine can be made to feed any desired length, the beds having been built to feed 12 feet, the bed in this case being 16 feet long.

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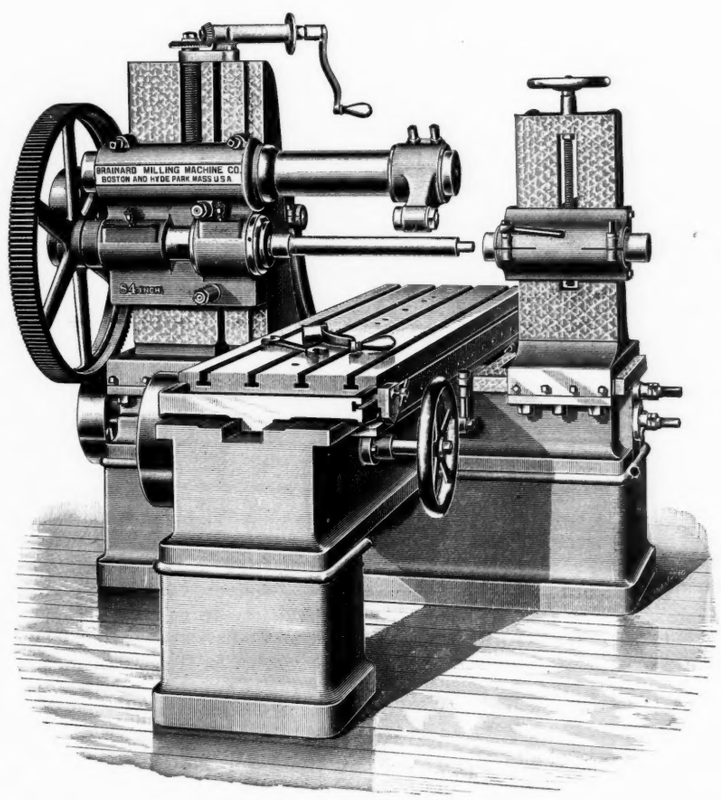
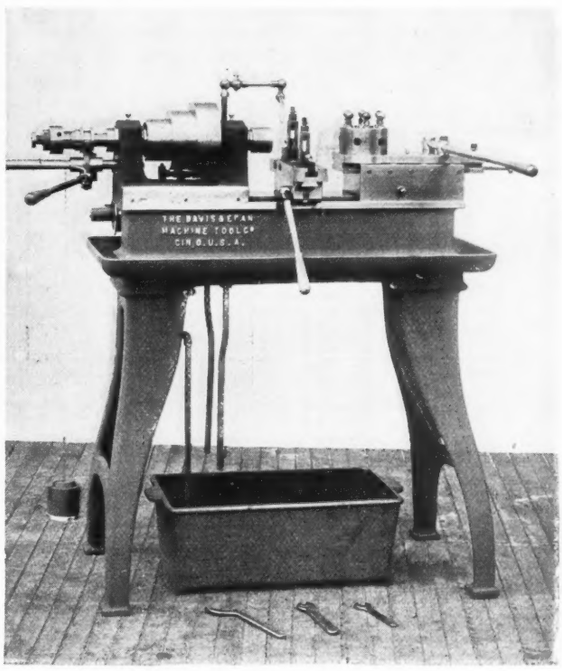


EIGHTY-FOUR INCH BRAINARD MILLING MACHINE.

HERR LILLIENTHALL, who has devoted considerable time to æroplanes and who had probably made more progress in the "flying machine" line than any other investigator, lost control of his machine on August 11th and, falling with it, broke his spine. A new machine, which he had nearly completed, provided for just such emergencies and had this been used he would probably be alive to-day.

NEW HALF-INCH SCREW MACHINE.

The accompanying cut illustrates a new half-inch screw machine which is just being put on the market by the Davis & Egan Machine Tool Co., of Cincinnati, O. The turret revolves



NEW HALF-INCH SCREW MACHINE.

automatically by a short movement of the lever, and has six holes for the reception of tools. The indexing mechanism is of hardened steel, and the locking-pin is forced into the various divisions by a spiral spring, the tension of which can be graduated to suit the requirements. The turret slide is provided with adjustments in all directions to insure perfect alignment with the spindle.

The cut-off rest is provided with rack and pinion, and has two tool-posts, which are fitted with adjustable taper wedges for regulating the height of the tools. It is often desirable to use a forming tool in one of the tool-posts, for making cups, cones and similar work. The bed is of the box form, dove tailed on the top, and is cast in one piece with the pan. The spindle is made from a special grade of steel, accurately ground, and runs in bronze boxes provided with the best oiling facilities. The wire feed is so arranged that the stock is fed forward instantly, and can be gripped or released while the machine is running.

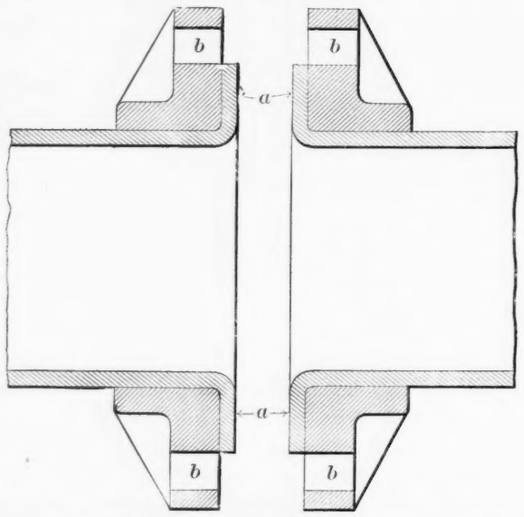
* * *

A NEW PIPE JOINT.

One of the annoying details of the use of high-pressure steam is the question of pipe joints, and many kinds of packing have been devised to overcome the difficulty. While some of these answer admirably, the question of a metal-to-metal joint has long been discussed and attempted in various ways. Flanges have been screwed on the pipe and the joints formed on the flanges, inside the bolt circle, but there is a tendency for the steam and moisture to work its way through the threads and give trouble, even when the end of the pipe has been riveted over on the flange. George I. Rockwood, M. E., of Worcester, Mass., well known in steam engineering circles for his radical views on compounding engines (which, by the way, are being accepted to a very considerable extent), has devised the joint shown herewith, as a way out of the difficulty. He is using these in a large steam plant which he is erecting for the Sterling Dyeing and Finishing Co., Sterling, Conn., the piping being of both 10 and 16 inches diameter.

It will be seen that the flange, which is a heavy casting, is

forced on the pipe a sufficient distance to allow the end to be flanged over against the casting, as shown. This is done more readily than could be imagined, and without injury to the metal. It would naturally be supposed that the correct method would be



to make the inside corner of the casting an easy curve of large radius, to avoid unnecessary strain on the pipe. This was done with the first ones and nearly every pipe-end split while being flanged. A short radius curve, just enough to round it over, is now used and there is practically no trouble experienced in making the flanges. Another case of the unexpected happening. After flanging, the faces of the pipe are faced off in the lathe, and when clamped together by the generous supply of flange bolts, it makes a joint which is practically as solid as the pipe, and there is no packing to blow out. These have proved so successful as well as inexpensive to construct, that the Walworth Mfg. Co., of Boston, Mass., who made the piping for the plant mentioned, have adopted this style of joint for pipes from 8 to 20 inches in diameter.

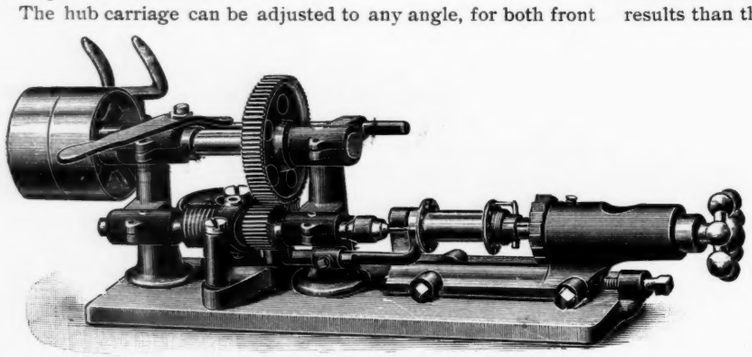
* * *

AUTOMATIC BICYCLE HUB DRILL.

The growth of the bicycle fever has had a marked effect on the machine trade, bringing out many very ingenious machines which tend to secure accurate work and to so cheapen it that even the alleged $12.00 bicycle from Japan shall have no terrors for our builders. One of the latest of these comes from the Stover Novelty Works, Freeport, Ill., and is illustrated herewith.

This machine automatically drills bicycle hubs without any attention, except to put the hub in and take it out. An ordinary boy can easily drill 25 hubs an hour with a single machine, and can operate two with ease.

The hub carriage can be adjusted to any angle, for both front



AUTOMATIC BICYCLE HUB DRILL.

and rear hub, so the drill will enter at right angles to the plane of rim. The machine is regularly furnished to take in hubs with holes in center from 1 to 1¼ inches, and has index ratchet to drill 32 holes and accurately spaced intermediate with holes in opposite end of hub. In operating the machine, stop the drill upon its return, before the index ratchet operates, then put in the hub. No countershaft is required.

* * *

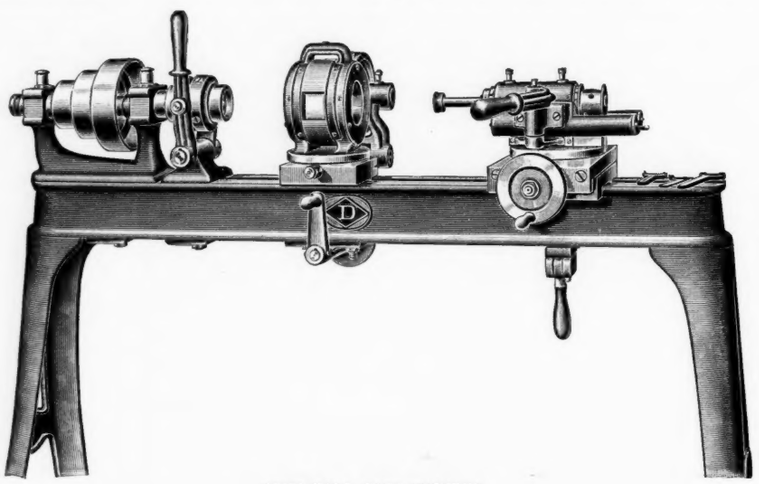
NEW BALL CASE GRINDER.

Among the many improvements which are being shown bicycle manufacturers is the '97 pattern Ball Case Grinder illustrated herewith.

This machine was put on the market some years since, at the time when the attention of manufacturers was being turned toward the subject of grinding their bearings; since that time some changes have been made in the details of the machine, but no such radical departure as are shown in this pattern.

In the old machine, the cups and cones were held in a three jawed chuck, which was slow to operate. The drawback chuck on the new machine is arranged to hold split collets of various sizes within its capacity, and these are fitted at the factory to cups and cones furnished by the bicycle maker. One movement of a lever serves to tighten or loosen the chuck as desired.

The revolving head shown in the center of the bed has a taper hole into which fits a specially designed chuck, so arranged that hubs may be held by the barrel or by the flange. If but one emery wheel is used, the head is swiveled half way around when one bearing is ground in order to grind the bearing at the other end of the hub. Sometimes two emery wheels are used, one on each end of the hub, in which case it is not necessary to revolve the head. This revolving head was formerly driven by a belt, but it is now propelled by a friction wheel shown in the rear and which is caused to engage with the head by a lever shown in



NEW BALL CASE GRINDER.

front, which actuates a cam wheel on the back of the machine.

The emery wheel slide rest was formerly made so that the spindle moved back and forth by means of a lever. This exposed some bearing surfaces to the action of emery dust. The present device of causing the whole rest to move on protected slides by means of a rack and pinion movement gives very much better results than the old methods.

The revolving head and the emery wheel spindle are both equipped with ball bearings, accurately ground. This permits a very high speed to the emery wheel without heating, and gives a better chance to protect the bearings from the entrance of emery dust.

We are told by the manufacturers, the Diamond Machine Co., of Providence, R. I., that they have sold about 200 of these tools to bicycle manufacturers in the United States, France, England and Germany.

* * *

THICK CYLINDERS AGAIN.

In addition to the data already published on thick cylinders for hydraulic purposes, it may be interesting to note the one made by the Morgan Construction Co., of Worcester, Mass., for Messrs. Wyman & Gordon, the well known makers of drop forgings, in that city. The cylinder is part of a heavy hydraulic forging press

made for forging car couplers, and has been in use for quite a long time at 2 000 pounds pressure per square inch.

The cylinder is of steel and was cast by the Midvale Steel Co., of Philadelphia, in 1893. It weighed 16 594 pounds, and was a splendid casting, as the writer knows from personal inspection during the boring operation. A test bar cut from the casting before annealing gave the following results:

Tensile strength.....	92 350 lbs. per square inch.
Extension.....	21.20 per cent.
Contraction.....	30.85 " "

The working bore of the cylinder was 36 inches, and allowing half an inch on each side for clearance of the ram, we can call it 37 inches internal diameter. Taking the formula suggested by Mr. Hemenway in the August issue, we have:

$$T = \frac{R \times P}{S - P}$$

Where T=thickness of wall in inches.
R=radius of cylinder in inches.
P=pressure in pounds per square inch.
S=safe working strength of metal per square inch.

Taking Mr. Cooper's assumption of 18 000 pounds safe stress for steel castings this gives us:

$$T = \frac{18\frac{1}{2} \times 2\,000}{18\,000 - 2\,000} = \frac{37\,000}{16\,000} = 2.31 \text{ inches.}$$

In reality it was made 4 inches thick, and transposing the formula to find what safe working strain was considered by the designer, assuming that he used the same formula as ourselves, we have:

$$S = \frac{R \times P}{T} + P$$

or

$$S = \frac{18\frac{1}{2} \times 2\,000}{4} + 2\,000 = \frac{37\,000}{4} + 2\,000 = 11\,250 \text{ pounds.}$$

This gives a factor of safety of 8.2 when compared with the tensile strength before annealing, and leaves a good margin after allowing for the reduction due to the cause. This adds weight to the formula given by Mr. Hemenway, which appears to be safe in every way.

* * *

HOW AND WHY.

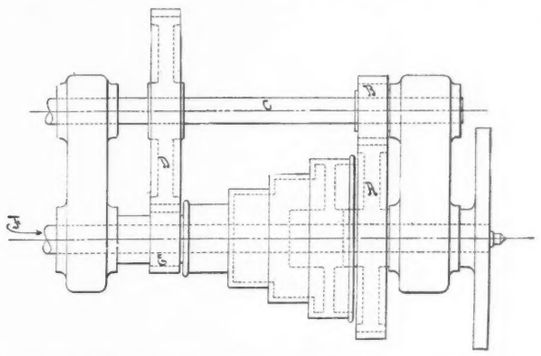
A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

1. J. B. asks: Is it practical to take up the study of algebra before completing common arithmetic? *A.* After one has thoroughly mastered addition, subtraction, multiplication and division, it is only a question of study and application until they can handle square and cube root, which have been clearly explained in "Machine Shop Arithmetic" in last year's MACHINERY, and is the book you mention. Having mastered these, you can easily use all the algebra you need in shop calculation by studying the chapter on "Formulas," and others which bear on the subject. A shopman's algebra is usually formulas, and by remembering that the letters represent numbers and are used for convenience, you will have little difficulty in mastering all the algebra you need.

2. A. X. writes: "I have a battery of boilers, 28 feet long and 46 inches in diameter, grate surface 54 square feet. What is the horse power, and how do you find it? *A.* It is difficult to estimate the power you can get out of this boiler. The usual practice is to take from half to two-thirds of the circumference as heating surface. This multiplied by the length gives the heating surface of the shell. This being a cylinder boiler without flues, this forms the entire heating surface. The diameter of 46 inches gives 144.5 inches circumference; two-thirds of this equals 96.2 inches, or 8.01 feet. Multiplied by 28 = 28 × 8.01 = 224.28. Dividing by 10, as the usual allowance is 10 square feet of heating surface per HP. for this type of boiler, we have 22.428 HP. Allowing only half the circumference as heating surface it becomes 16.85 HP. The grate surface is larger than usual for the heating surface, and we are inclined to agree with quite an authority on boilers that "the less said about cylinder boilers the better for all concerned."

3. N. J. H. We don't know of any cheap spiral head for milling reamers and cutters. You can probably devise one for your particular case, although it is probable that one can be bought cheaper than it can be made in the ordinary shop.

4. C. E. sends the following sketch and asks for light on the question of back gearing. *A.* Your trouble seems to be in considering all the gears as keyed fast to the shafts, in which case they would not run, as you say. Taking the cone first, as the belt drives this, and we find the pinion E fastened to the cone, but the cone and gear run loose on the shaft F. Pinion E drives D, and as D and B are keyed to shaft C, C revolves as much slower than the



cone as the ratio of gearing (3 to 1 in this case). Pinion B drives gear A, which is keyed to shaft F, at ⅓ of the speed of C (in this case) or $\frac{1}{9}$ of the cone speed and the back gear is said to be 9 to 1. If we throw out the back gear and lock gear A to the cone by the bolt or other method provided for that purpose, the shaft F will run at the same speed as the cone and this will depend on which step the belt is run. If the back gear is thrown in with the cone and gear A still locked, there can be no movement (other than the lost motion of the gear teeth) as the cone, which should revolve 9 times as fast as the gear A with the back gear in, is locked solidly to it. This question may be discussed at greater length in a later issue.

5. E. W. writes: I have seen a query in another journal as to whether ball bearings ever heated or not. Can you tell me? *A.* Some of our bicycle repairing friends tell us that they have repaired wheels in which the bearings (ball races) were drawn to a "blue" from being left dry and having heated. Others claim to ride their wheels without ever oiling the bearings.

6. H. S. What should be the size and area of the steam port for a 20 x 36 inch slide valve engine running 100 revolutions per minute? *A.* This equals 600 feet piston speed and it is customary to make the steam port about .09 of the piston area for this piston speed. The area of a 20 inch piston is 314.16 square inches. Multiplying 314.16 × .09 = 28.27 square inches as the area of port. A very common proportion would be a port 20 inches long by 1½ inches wide. This would give 30 inches area instead of 28.27, and if exact figures were considered necessary, the port can be made 20 x 1.41 inches.

7. M. H. asks about cutting a ¾-inch keyway in a shaft. How deep should it be and where is it measured? *A.* Practice varies in different parts of the country and in different countries. English practice makes the thickness of the key one-half the breadth, and sinks the key ⅓ of its thickness in the shaft, measured from the side of keyway. We prefer using a key about square and sinking it half way in shaft, measured from the side of keyway for convenience, although we believe some measure from center. In practice it makes very little difference which way it is measured.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

MORE ABOUT LUBRICATED CUTTERS.

The feed of milling cutter was ⅜ inches per minute on steel, 9 inches per minute on cast iron. The cutter was made of tool steel. Enclosed find a piece of one of the teeth broken off by knocking against another cutter in the tool room. The lubricant used is whale oil soap, 10 pounds; sal soda, 15 pounds; lard oil, 2 gallons,

and add water to make 40 gallons. This makes a clean cut on cast iron or steel and does not glaze. S. ASHTON HAND.

Philadelphia, Pa.

[This was received too late to appear in the article, but is particularly interesting in regard to lubricating cast iron for cutting.—ED].

TRACING CLOTH VS. BOND PAPER.

In my article, "Machine Drawings for the Shop," published in your February issue, I made the following statement: "Tracing cloth should never be used, for it cannot be kept in good condition to get blue prints." In the July issue, a correspondent alludes to my assertion and refers to an apprentice (whom, I am led to suppose served under him), who soaked the tracing cloth instead of the sensitized paper.

I realized when I wrote the article referred to, that the statement which was made, was very broad, and that there would be a great many draftsmen who would not agree with me; but I can assure them that the assertion was not made until after years of experience with both tracing cloth and bond paper and a careful study of their merits.

In a well conducted drawing room, every drawing which goes into the shop should have its duplicate in the drawing room, or, as is usually the case, the duplicate goes to the shop and the original stays in the drawing room, for we send the blue print out and retain the original drawing.

In photography, in order to get a good print, we must first have a good negative, and if it has been scratched, or the film has been damaged, we get an unsatisfactory picture. The same applies to blue printing a drawing; if the tracing is not in good condition we do not get a good blue print. This has been the reason for abolishing its use in the office where I have charge. My experience has been that when tracing cloth gets old it breaks easily. I cannot say "tear" in this case, for it is not a tear, but a break. For instance, suppose we happen to bend over the corner of our tracing and lay it at the bottom of a pile in one of our filing drawers, the next time that drawing is taken out, in all probability we can pull that corner off where it was bent, and if we cannot do that, when the blue print is taken we will have a mark on the print where the tracing was creased, which does not add to its usefulness.

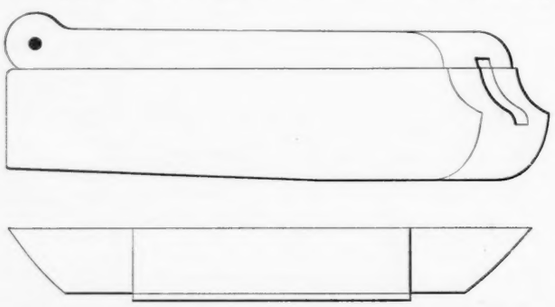
Tracing cloth does not lay in drawers as well as bond paper. I have both tracing cloth and bond paper filed away in my office, and I find in looking over the tracings that there are some which are creased across the lines of the drawing which makes it very bad when the print is taken. I have no trouble in this line with bond paper, and if for no other reason than this I should decide in its favor.

Drawings can be inked more accurately by inking the original pencil drawing than by tracing, and I find it can be done more rapidly, which is another advantage for bond paper.

I never tried to soak tracing cloth or bond paper until I read my friends objection to my statement, so I had the boy who takes the blue prints soak a bond paper sketch for me. He soaked this ten minutes and after drying, took as good a print as he had taken just before he soaked the drawing. My friend writes "tracing cloth will stand anything but soaking, but I don't know about bond paper." I can reply, quoting him as authority for soaking tracings, by saying, bond paper will stand soaking, but tracing cloth will not. ARTHUR B. BABBITT.

CUTTING-OFF TOOL.

The sketch makes this device fairly clear, the lower part of the holder (upper sketch), having a projection for a hinge joint and also being grooved to receive the tool itself. The top or cap is



hinged to this and also milled about ⅛-inch deep, to hold the tool from moving sideways. I use blades ⅛ x ½-inch, ⅛ x ¾-inch and ⅛ x 1-inch, according to size of lathe.

The second sketch shows a double ended cutting-off tool which is very convenient. It should have clearance on sides for free cutting. It will be understood that the cap bears on the tool and not on the lower part, and so clamps the tool firmly when it is fastened in the tool post. A. L. R.

THE TAIL-STOCK FACE-PLATE.

In how many shops will you find a tail-stock face-plate? The answer will be very few. You will find, perhaps, a few drilling plates or V centers, which in their way will do for some kinds of work, but a machinist who has never used a tail-stock face-plate is not in it. Such a plate should be of large diameter and have numerous slots and holes for bolting various kinds of work. It need not be as heavy as the ordinary face-plates, as the strain is not as great as on one used on the spindle of lathe.

Now for its uses. You have a large number of small bearings to bore. What a job it is as ordinarily done in the average shop. With the tail-stock face-plate all you will have to do is to bolt a small angle plate to same, fasten adjusting pieces and place a bearing on same, properly fastened, put a chuck on mandrel and place a suitable drill in chuck and how easy it is; and all of the bearings will be just alike. If necessary, you can use a combined drill and reamer, and both drill and ream the hole at the same-time. A pair of vise jaws can be fitted to hold odd shaped pieces, which will enable you to do some of the seemingly difficult kinds of work.

Our outfit will not be complete without a small plate fitted with a joint at the center to fit in tail-spindle, so the plate can be set at any angle, and if it is fitted with holes to take small pins or bolts, the trouble of drilling some of the difficult pieces, whose sides are at different angles to each other, will be greatly lessened.

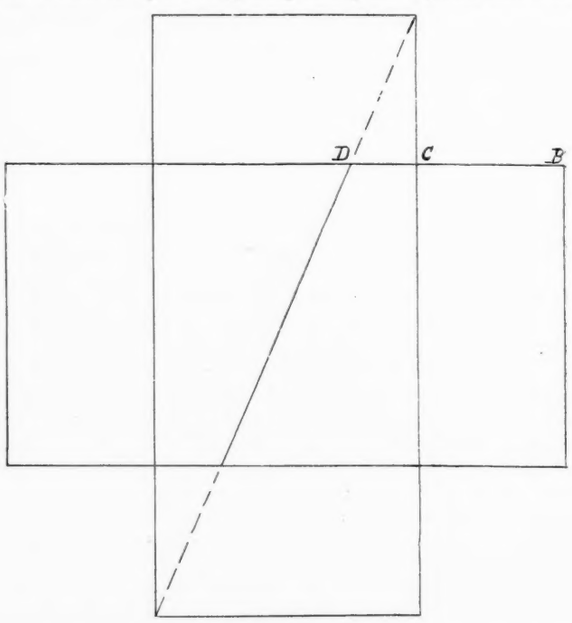
Angelica, N. Y. F. H. JACKSON.

THAT FOLDED PARALLELOGRAM.

You are right Mr. Editor, the formula I gave will only hold good when the length is two units greater than the width. The following, I think, will be correct in all cases:

$\frac{\text{Length} - \text{width}}{2} = a$, then $a + \frac{\text{width} \times a}{\text{length}} =$ the answer required.

It is deduced by drawing the parallogram required and drawing a duplicate over the first—centrally and at right angles to the first. The fold in the first will just hit the corners of the second.



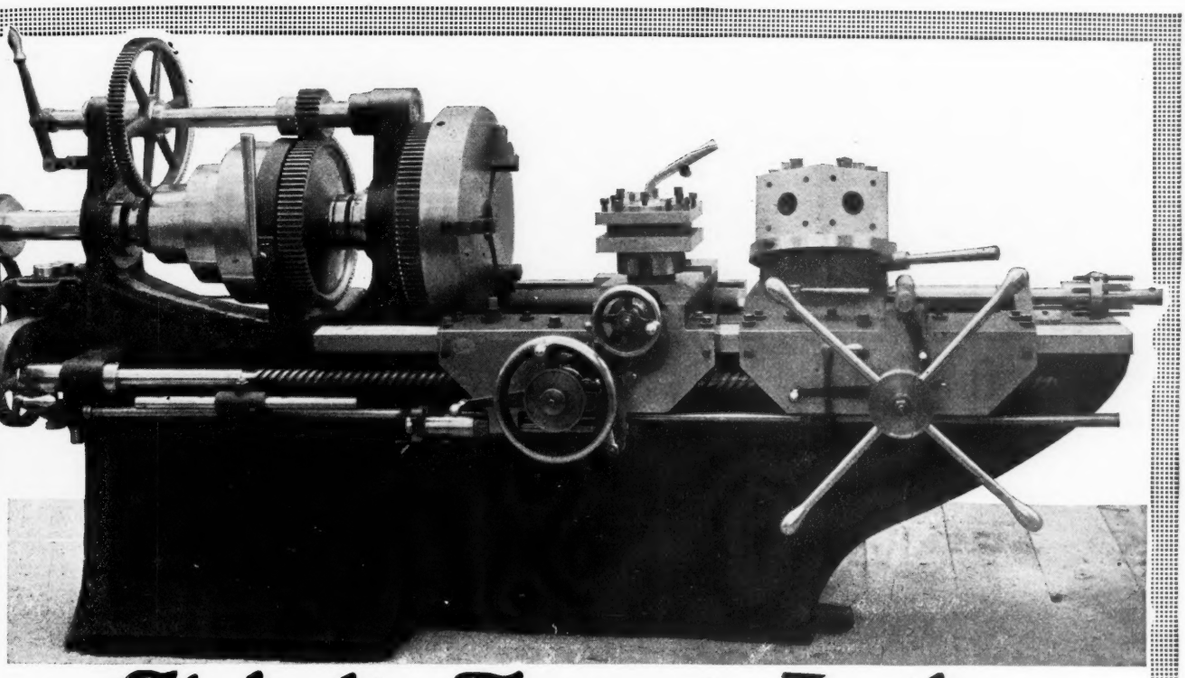
Then $b\,c$ of the drawing $= a$ of the formula and $c\,d = \frac{\text{width} \times a}{\text{length}}$.

C. W. SHEDD.

CHIMNEY CALCULATIONS.

Among my other duties, I have been called upon to design a smoke-stack for a new steam plant with a maximum of 6 600 indicated horse power and 7 680 boiler horse power.

As one inch more or less in the diameter of a chimney of such a capacity means quite a little money, I decided to spend some time in computing this smoke-stack. From various hand-books



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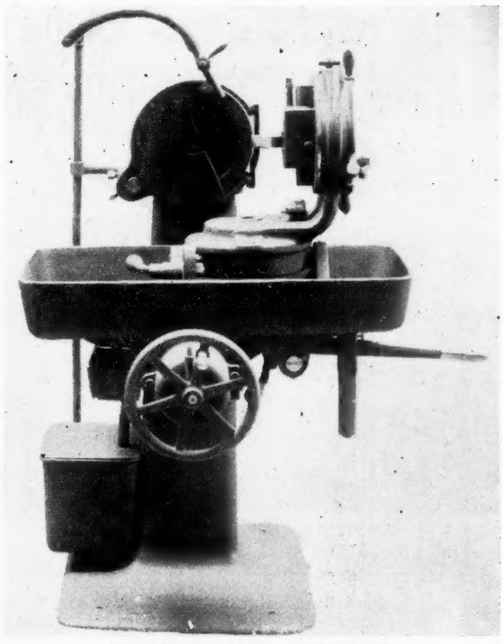

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for engineers, technical papers and books, etc., I compiled twelve different formulas, from which I got answers varying from 13 feet 1 inch to 15 feet 6 inches, for the diameter for a given height, which of course shows that there is something wrong in the formulas, at least in some of them. If 13 feet 1 inch would be enough, then it would certainly be most uneconomical to spend money in enlarging it 2 feet 5 inches, which would cost several thousand dollars. The generally accepted formula seems to be that of William Kent, which is arrived at from the fact that a certain chimney of a certain height and diameter in actual use gave good results. But this stack connected to other boilers under other conditions perhaps would not have given satisfactory results. I mean that there are other conditions which govern the dimensions of a chimney than those given in the formula of William Kent and others, and that I do not believe that one general formula can be had which is good for every smoke-stack; at least it ought to have one or more constants either added to it or multiplied by it, which constants should have reference:

First. To the distance from boiler to stack, so that the greater the distance, the higher the stack.

Second. To the capacity of the boilers or engines, if you please, so that the greater the number of horse power developed, the smaller the increase of the diameter needs to be.

Third. To the temperature of gases, so that the higher the temperature, the lower the stack may be.

Fourth. To the air space between the grate bars, so that the less the air space, the higher the stack needs to be, and

Fifth. To the kind and size of coal, so that the smaller the pieces of coal, the higher the stack needs to be, all with the view of conveying a certain number of heat units to the boiler.

With all this in view, I designed the stack without the use of any of these formulas. I first figured the volume of gases from one pound of the coal to be used, burnt under poor conditions and with a low chimney temperature. I then decided on a certain velocity for the gases, leaving the chimney the lowest, I thought advisable, and from this I found the lowest height of the chimney, and the area of stack necessary per pound of coal. I then found how much coal I must burn for the required power, and thus arrived at the required area of stack for this height, if no friction existed in the stack. Considering then this friction with its retarding action for this velocity, I had to increase the area of the stack a certain amount. Further with regard to friction through tubes, combustion chamber, through the coal bed, grate bars, etc., I figured how many pounds of coal I could burn per square foot of grate surface, and thus arrived at the grate area given. Now, I found this in the first instance to be too large for the heating surface, as a large grate surface is more difficult to handle, and through a slower combustion a high fire temperature is harder to get. I increased the speed of the gases and have, as I think now, designed a stack of good proportion.

In the case in point there were several boilers; thus the grate area found had to be divided by the number of boilers. The boilers are of the return tubular type, and the smoke-stack has to be made of brick, round and of equal diameter inside.

I send this to your valuable paper, with a view of submitting it to the criticism of your readers. I shall be very glad to see this subject taken up by chimney builders and engineers who have had experience in designing stacks, as well as stationary engineers, who may give their experience regarding smoke-stacks which they are operating. In short, I should like the subject thoroughly discussed, both with regard to shape and size of core as to the outside walls and foundation, not only for my own sake, but from the fact that it would be of value to many besides myself. From stationary engineers I wish to get all data as to their stacks, boilers, etc., and where the defects are to be found, if any. This is a subject of great interest, and has been too little discussed heretofore.

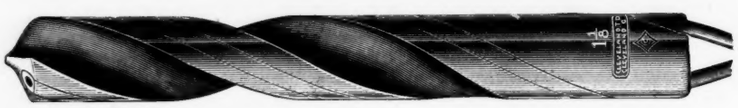
A. G. CARLSON.

Chicago, Ill.

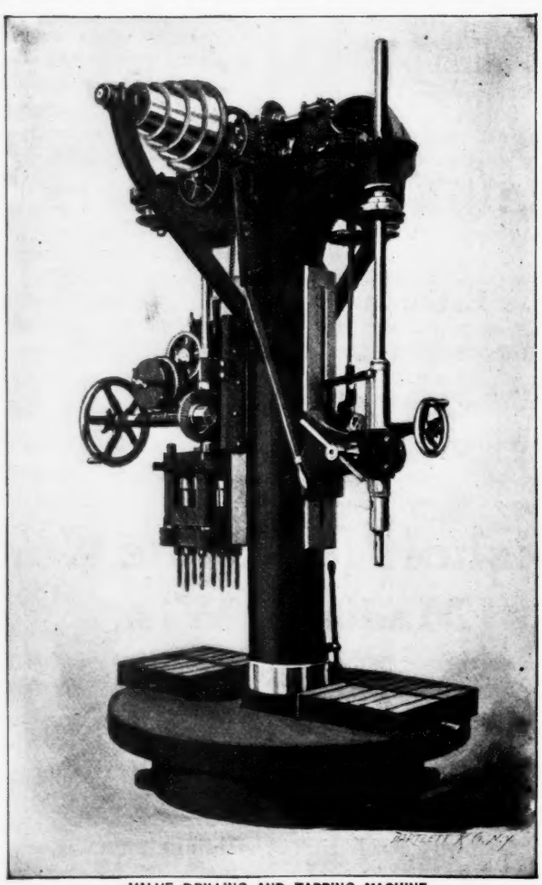
* * *

LUBRICATING DRILLS.

The question of forcing drills into heavy work depends largely on



whether the cutting edge can be kept cool as well as clearing the chips



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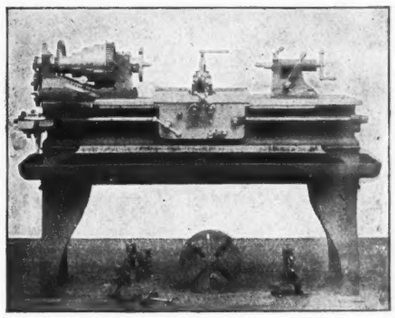
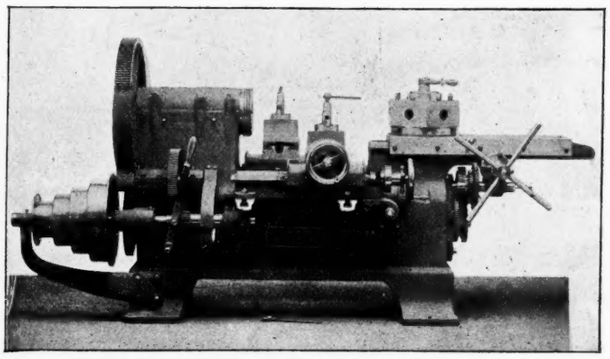


The Lodge & Shipley Machine Tool Company

Cincinnatti, Ohio, U. S. A.



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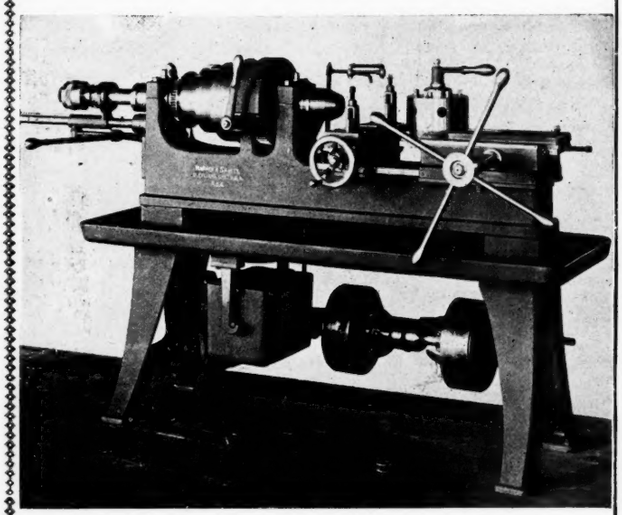

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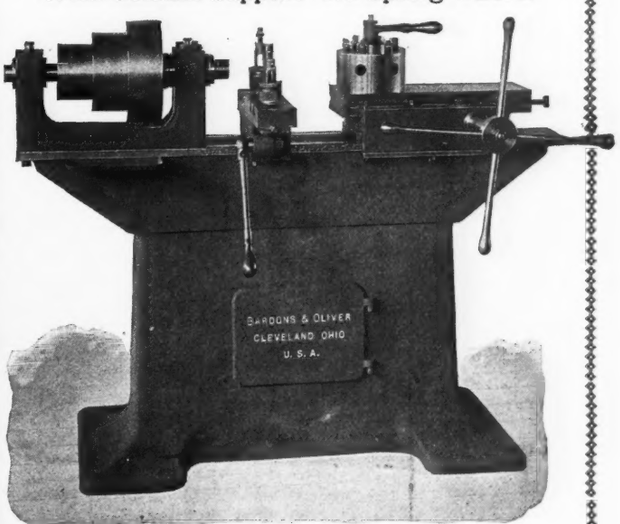


Extra Attachments can be furnished as follows:—Automatic Chuck, Vertical Forming Tool Slide, Wire Feed, Automatic Feed to Turret Slide, FrictionBack Gears and Triple Friction Countershaft. Prices quoted on application.

Bardons & Oliver,

Cleveland, Ohio,

U. S. A.

out of the way. The occasional squirting of oil from a can into the groove does little real good, as the oil never reaches the desired point —the cutting edge of the drill. The drill shown has a small brass tube soldered into a groove milled in the "band" of the drill, the rear ends being connected to a supply of oil under pressure. This floods the cutting edges, keeps them cool and washes the chips away from the drill point. They are made from 3-4 to 1 5-16 inch by the Cleveland Twist Drill Co., Lake and Kirtland Streets, Cleveland, Ohio.—*Adv.*

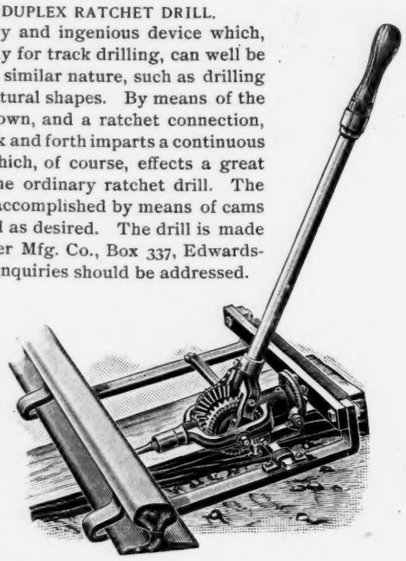
* * *

MANUFACTURERS' NOTES.

IT is refreshing to hear something cheerful occasionally, and a letter from Wm. Baragwanath & Son, 49 West Division Street, Chicago, Ill., stating that both July and August have been exceptionally busy months, is very welcome. Their orders for those months range from 75 to 2 500 horse power heaters, and will foot up to a big total. They have also had numerous inquiries for their "Steam Jacket Heater" and "Siphon Condenser," and consider the outlook for the fall as very bright.

* * *

DUPLEX RATCHET DRILL.



This is a very handy and ingenious device which, though made especially for track drilling, can well be used on any work of a similar nature, such as drilling beams and other structural shapes. By means of the double bevel gears shown, and a ratchet connection, moving the handle back and forth imparts a continuous motion to the drill, which, of course, effects a great saving of time over the ordinary ratchet drill. The feed is automatically accomplished by means of cams which can be regulated as desired. The drill is made by the Bignall & Keeler Mfg. Co., Box 337, Edwardsville, Ill., to whom all inquiries should be addressed.

THE JEFFREY MANUFACTURING COMPANY, of Columbus, Ohio, have taken up the manufacture of the Robinson Patented Coal Washing Machinery. There are many in daily use in this and foreign countries and it is conceded to be a most efficient and simple washer. Points of special advantage are: its simplicity, compactness, low cost of installation, low cost of operation, economy in the use of water, and its washing of coal that is not closely sized. Catalogs will be sent on application.

THE DAVIS & EGAN MACHINE TOOL CO., of Cincinnati, Ohio, have just brought out a new hub machine that will form, drill and cut off 100 rear hubs in ten hours. They have orders on their books now for this machine from England, France, Denmark, Sweden, Canada and quite a number in the United States, and report an exceptionally good business in the foreign trade for bicycle machinery.

AMONG the equipments recently furnished by the American Stoker Co., are the following: Pennsylvania Railroad Co. shops, Columbus, Ohio; Davis & Egan Machine Tool Co. and the John C. Roth Packing Co., of Cincinnati, Ohio; Toledo Brewing and Malting Co., Toledo, Ohio; Michigan Carbon Works, Detroit, Mich., second order; Cleveland City Water Works, Cleveland, Ohio.

* * *

FRESH FROM THE PRESS.

Opening Bridges. George Wilson, M. Sc. Technical Publishing Co., Manchester, Eng. 56 pages, 5½ x 8½ inches. Two shillings, net.

This little book contains much of interest and value on a subject which has received too little attention in works on bridge building. It contains considerable data as well as calculations of the various essential features, which insure the book being preserved for reference by all interested in this subject.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

NEWTON MACHINE TOOL WORKS, Philadelphia. Booklet No. 32.

This is a twelve page booklet of new boring, drilling and milling machines, the first shown being a horizontal machine combining all three without undue complication. Numerous machines are shown which give an idea of the variety and general design of the machines manufactured by them.

F. E. REED COMPANY, 120 Gold Street, Worcester, Mass. Catalog of lathes.

This illustrates the bearings and other details of the Reed lathe and gives a good idea of their different sizes and styles, which range from 9 inch hand lathes to 30 inch engine lathes of massive design. Slide rests, planer centers and very convenient scraper tables are also shown.

JOHN ROYLE & SONS, Paterson, N. J. Circulars.

These are devoted to showing the variety of machines made by this firm for use in the various branches of engraving, which has assumed large proportions within the last few years.

P. & F. CORBIN, New Britain, Conn. Catalog of Screws.

This is a substantially bound catalog of 56 pages, showing the variety of screws, nuts, washers, etc., made by this firm. It is very handy for reference, as it enables one to specify screws which are regularly made rather than order something special at an advanced price.

THE latest issue of the Four-Track Series—"Two Days at Niagara Falls"—is one of its most attractive numbers. It is a narrow booklet of 64 pages, printed on heavy coated paper with illuminated cover. It is full of reproductions of photographs of scenes about the Falls and that wonderful thirty-eight miles of river, gorge and cataract, extending from Buffalo, on Lake Erie, to Youngstown, on Lake Ontario, through which rush the waters of the Great Lakes on their way to the ocean. Most of the pictures are so remarkable that one can hardly believe that he is looking at an actual scene of nature, and becomes impressed with the idea that it is a fancy sketch before him; but all are reproductions of photographs. A copy of No. 9—"Two Days at Niagara Falls"—will be sent free, postpaid, to any address, on receipt of two 2-cent stamps by George H. Daniels, General Passener Agent New York Central Railroad, Grand Central Station, New York.

GENERAL HORACE PORTER'S personal recollections of General Grant, which *The Century* will publish beginning in November, are to be called "Campaigning with Grant." General Porter first met General Grant at Chatanooga; he soon became attached to his staff, and was with him constantly from that time until the close of General Grant's first term as President, during which he was Grant's private secretary.

THE KILBOURNE & JACOBS MFG. CO., Columbus, Ohio. Catalog of Wheelbarrows.

This might be called a contractors' catalog, as it contains a full line of tools used by them in the way of barrows, scrapers, ploughs, dump carts, etc. It also contains some useful information concerning cost of excavations and basis of estimates on this kind of work.

THE JEFFREY MFG. CO., Columbus, Ohio Catalog of Coal Washing Machinery.

This contains a description of the Robinson Coal Washer which is now in successful operation in sizes ranging from 50 to 400 tons per day. The increased value of washed coal makes it a good investment, not only for mine operators but for large consumers. The method of selling is both novel and sensible. They have erected a washing plant at their works and before giving an estimate wash, a carload of coal, so as to thoroughly test the adaptation of the method to the coal in question, thus determining the result before making any contracts or guarantees, a procedure which might be followed to advantage by others.

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